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CALIFORNIA BUSH-TIT (PSALTRIPARUS MINIMUS CALIFORNICUS).

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U. S. DEPARTMENT OF AGRICULTURE

BIOLOGICAL SURVEY—BULLETIN No. 30

C. HART MERRIAM, *Chief*

BIRDS OF CALIFORNIA

IN RELATION TO THE FRUIT INDUSTRY

PART I

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WASHINGTON

GOVERNMENT PRINTING OFFICE

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Biological Survey,
Washington, D. C., July 27, 1907.

Sir: I have the honor to transmit herewith as Bulletin No. 30 of the Biological Survey, Part I of a report on the Birds of California in Relation to the Fruit Industry, by F. E. L. Beal. Fruit raising in California is a great and growing industry, and the relation birds bear to it is important. The investigations embodied in the present report were undertaken with a view to the accurate determination of the economic status of every species of California bird that inhabits orchards, in order that it may be possible for the fruit raiser to discriminate between friends and foes; and for the added purpose of suggesting remedial measures for the protection of fruit from destructive species. As expected, the strictly insectivorous birds prove to be almost wholly beneficial, by far the greater percentage of the insects eaten by them being injurious kinds. They are hence allies of the orchardist and their presence in and near orchards should be encouraged in every way. Of the species addicted to fruit eating, not one was found to make its diet wholly, or even chiefly, of fruit; and the fruit eaters, with possibly the exception of the house finch, are found to feed upon weed seeds and noxious insects to such an extent as to fully offset their destructive propensities.

Respectfully,

C. Hart Merriam,
Chief, Biological Survey.

Hon. James Wilson,
Secretary of Agriculture.

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BIRDS OF CALIFORNIA IN RELATION TO THE FRUIT INDUSTRY—PART I.

INTRODUCTION.

In response to numerous complaints from fruit growers concerning depredations by birds in orchards and vineyards in the Pacific coast region, investigation of the subject was undertaken by the Biological Survey several years ago. In conducting this investigation the writer spent about nineteen months in California, including the fruit seasons of 1901, 1903, and 1906, during which time he visited the most important fruit-growing regions of the State, inspected hundreds of orchards, and interviewed many fruit growers. Kindness and courtesy were everywhere met with, and every facility was extended by orchardists for the acquisition of information, even to a suspension of the customary rules with regard to trespass and shooting on private grounds. In addition to the knowledge gained by field observations, stomachs of all the species of Pacific coast birds economically valuable have been collected, examined, and their contents recorded.

When depredations are so widespread and involve so many different species of birds, a thorough knowledge of the nature and extent of the damage done and of the attending circumstances is of great importance. Next in importance is a knowledge of the conditions that obtain in fruit-growing regions where depredations by birds do not occur. This information should enable the fruit grower to adjust conditions in his own case so as to mitigate if not wholly prevent the evil.

In the following pages much stress is laid on the nature of the yearly or seasonal food of some of the more important species of birds, since it often happens that certain birds are more or less harmful to a particular crop of fruit, and yet the year through, all things considered, do more good than harm. It must not be forgotten in this connection that there are very few birds whose habits are wholly beneficial. Most of them are neither wholly beneficial nor wholly injurious. They are beneficial at some seasons and injurious at others. In some localities they are deservedly praised for benefits conferred; in others the same species are condemned for destructive

habits. With the evidence all in, it is usually possible for the farmer to properly estimate the status of any given species with reference to his own farm and his own interests and to adopt measures accordingly.

It can not be too thoroughly insisted that sound public policy everywhere forbids the destruction of birds on a large scale for the purpose of protecting orchard fruits. Wholesale slaughter of birds in the supposed interest of the orchardist is fortunately rare and often proceeds from a mistaken idea of their economic relations. When it is understood that the damage by a certain species is local and exceptional, that the birds in question are on the whole beneficial and that their destruction will be a loss to the State, the farmer and the orchardist are usually willing to adopt less drastic measures in defense of their crops and to spare the birds for the sake of the general weal.

STATUS OF BIRDS IN NEWLY SETTLED REGIONS.

When a new country is settled, large areas are plowed and brought under cultivation. In the process great numbers of native shrubs, weeds, and grasses are destroyed, and various new and exotic plants and trees are substituted. Coincident with this change in the vegetable life, and as a necessary consequence of it, great changes in the conditions and distribution of animal life take place. Some species are restricted in distribution and greatly reduced in numbers, or even exterminated, while others become more abundant and more widely dispersed. The reduction in numbers may occur from actual killing by man, from the destruction of natural breeding sites through clearing, and from a diminution of food traceable to the same cause. The results are exactly the opposite when cultivation and planting afford a more abundant supply of food, greater facilities for breeding, and better protection from enemies. The natural result of such conditions is a marked increase in number of the favored species, and this increase probably explains the great devastation of crops by birds that occurred on the Atlantic seaboard soon after the first settlements, and then successively in the States to the westward as these were gradually settled.

The early days of agriculture in California offer an interesting case in point. When the native grasses and weeds of the fertile valleys were destroyed to make room for grain, many species of birds, notably blackbirds and quails, were suddenly deprived of their natural subsistence and in place of it were supplied with an abundance of new and nutritious food. Naturally they preferred the cultivated grains (wheat, barley, and oats) to the wild oats (*Avena fatua*) upon which they had largely depended. Still later, when many of the

grain fields gave way to extensive orchards, which gradually crept up the hillsides and into the canyons, other species of birds began to utilize the new kinds of food and also the safe nesting sites afforded by orchard trees. Species that previously attracted little attention soon increased in numbers because of the increased food supply, additional facilities for nesting, and the protection afforded by man, who killed or drove away their natural enemies. As a result, some of them suddenly became of great economic importance, owing to their increased numbers and destructive habits.

MIGRATION OF BIRDS.

Owing to its extent and varied topography, California is rich in birds, both in species and individuals. Here altitude and topography, as well as latitude, govern climate. This fact leads to many peculiarities in distribution and complicates the study of birds in their economic and other relations. The movements of birds, too, are more complex than in the eastern part of the United States. The regular migration north in the spring and south in the fall, which is the rule over the greater part of the country, is here supplemented, in the case of many species, by a migration from the mountains, where they breed, to the valleys, where they winter. Besides the regular migrations, at times remarkable incursions of a single species take place. Such was the flight of mountain tanagers (*Piranga ludoviciana*) in the valleys in May, 1896. In several parts of California these birds appeared in immense numbers in localities where previously they had been rarely observed. Their appearance coincided nearly with the ripening of the cherry crop, to which in some places they did much damage in spite of the fact that great numbers of them were shot.

CAUSES OF DEPREDATIONS BY BIRDS.

The failure of customary food supply sometimes leads birds to forage upon crops which they do not commonly eat. This may be the explanation of the depredations of robins in the fall and winter of 1900–1901, when thousands of these birds pillaged the olive orchards in Santa Clara Valley, the region about Santa Barbara, and other parts of California. In that year it was as much as the olive growers could do to save part of their crop. Since then no case of excessive loss of olives has been reported, though occasionally some damage has been done.

The amount of damage inflicted by birds upon a crop often depends upon the surroundings. In the case of orchards in the midst of a treeless plain depredations are mostly confined to such birds as nest in them, but they may be visited and damaged by others during

migration. On the other hand, fruit grown near or in brushy canyons or on wooded hills is taken by birds that live in such places; or a stream flowing through a region of orchards may harbor in the shrubbery on its banks many birds that do not live in the orchard itself.

Hence depredations by birds may arise: (1) From the settlement of a region and consequent introduction of new crops, accompanied by a diminished supply of natural food, destruction of enemies, and a general change of natural conditions; (2) from failure of the normal food supply, causing migration in search of food, or an attack upon some product which the species does not usually eat; (3) from proximity to a particular crop, in which case the bird naturally eats that which is most available.

CONDITIONS IN CALIFORNIA COMPARED WITH THOSE IN THE EASTERN STATES.

Before proceeding to a consideration of particular birds, one point should be specially noted in connection with the subject of the relation of birds to fruit in California. Those parts of the State where fruit is grown are not so well supplied with wild fruits on which birds feed as are the fruit-growing areas of the Eastern States, or even of those farther north on the Pacific coast. While California has an abundance of wild berries which serve as food for birds, they do not commonly grow near orchards and vineyards.

In the Eastern States a plentiful supply of fruit, as acceptable to birds as the best products of the orchard or garden (perhaps more acceptable), is usually present in pastures and along roadsides, so that it is only where wild fruits are exterminated by cultivation that birds are forced to eat cultivated kinds. So abundant is wild fruit in some regions, as in the United States east of the Alleghanies, that it is safe to say that thousands of bushels of blackberries and raspberries which grow wild everywhere annually fall to the ground and rot, in spite of the fact that great quantities are gathered and eaten by man as well as by birds. The same is true of blueberries (Vaccinium) and huckleberries (Gaylussacia), which are so abundant in a wild state that in their season they appear in the markets of most of the cities and large towns, and are eaten in every country home in the region where they grow. In addition to these are several species of dogwood (Cornus), holly (Ilex), cherry (Prunus), Viburnum, and many others, all of which are freely eaten by birds.

Although many of these fruit-bearing shrubs are represented in California by related species, they usually grow in the mountains remote from fruit-growing districts. In fact, the elderberry (Sambucus), the introduced pepperberry (*Schinus molle*), and an occasional mistletoe berry are the only important uncultivated fruits

that appear in the stomachs of California orchard birds. On the other hand, in the Eastern States more than 40 species of wild fruits have been found in the stomachs of a single species—the Eastern robin. In the general dearth of wild fruits on the horticultural areas of the Pacific coast it is not surprising that when domestic fruits were first cultivated there the birds gave them a warm welcome, and the orchardist's crops suffered accordingly.

Another reason why birds attack fruit in California more than in the regions farther east is the dryness of the summers, juicy fruits proving an acceptable substitute for water. To secure enough water for their necessities California birds must often fly several miles, while in the Eastern States localities are few in which water can not be obtained within a few rods. In confirmation of the theory that in attacking fruit liquid for slaking thirst is sought by birds as much as food, it may be stated that much of the injury done to small juicy fruits in California, such as grapes and cherries, consists of simple punctures in the skin, through which apparently nothing but juice has been drawn.

PROTECTIVE MEASURES.

It would appear most desirable that some of the available fruit-bearing trees, the fruits of which are of little or no value to man, but which to birds are even more acceptable than cultivated kinds, should be freely introduced into California for the protection of the orchardist. That some of them would thrive there hardly admits of doubt. *Morus alba*, the Russian mulberry, is one of the best, the fruit having little value unless as food for birds. All fruit-eating species are fond of it. Both the red and the black mulberries are equally sought after, but are not often planted for birds alone. The paper mulberry (*Broussonetia papyrifera*) is hardy and is a favorite bird food. Several species of Prunus or cherry, including the choke cherry (*P. virginiana*), and especially its western form (*P. demissa*), the black cherry (*P. serotina*), and the bird cherry (*P. pennsylvanica*) are of great value in protecting fruit crops, birds almost invariably selecting their fruit in preference to the cultivated varieties. There are also several ornamental varieties of cherries, such as the European birdcherry (*P. avium*), *P. pendula* of Japan, and *P. sphærocarpa* of Brazil, which are hardy, the latter in warm regions only, and valuable as bird foods. Both the pepper tree, *Schinus molle*, and the elder, Sambucus, now abundant in California, are eaten by many birds, and both may be planted near orchards with the certainty that they will serve to protect them.

Another measure recommended for the protection of orchard fruit is a supply of water accessible to the birds. Drinking places for birds in every large orchard would tend to reduce the injury done to

fruit, and would serve the added purpose of attracting insectivorous birds to the locality. Birds undoubtedly select breeding places with reference to the convenience of food and water, and a constant supply of the latter attracts to the vicinity many desirable species. The insectivorous kinds would more than pay the orchardist for his trouble in their behalf by feeding upon the insects that injure his trees; while fruit-eating species, like the linnet, being able to quench their thirst with water, would not be compelled to resort to fruit for this purpose.

The writer once observed a leaky hydrant situated between two rather extensive areas of orchards. The little pool maintained by the drip of this pipe was almost constantly surrounded by birds which all the time were coming and going, so that the number that visited it each day must have been well up in the thousands. An arrangement for this purpose need be neither elaborate nor expensive, and would serve a useful purpose.

READJUSTMENT OF CONDITIONS.

In relation to the destruction of crops by birds in a comparatively newly planted region, experience everywhere shows that after a time there is a partial readjustment of conditions, so that inroads by birds become much less common or wholly cease. On the Atlantic side of the continent at the present time, with the exception of the ravages of bobolinks in the rice fields of the southeastern coast States, few if any cases are known of the annual destruction of crops by birds, while during the first half of the nineteenth century the several species of blackbirds were a constant menace to grain. Present immunity results from the fact that increased density of population has destroyed the nesting sites and reduced the numbers of some of the most noxious birds. This readjustment of conditions is likely to take place sooner or later in all cases where the balance of nature is disturbed, but in most cases the process may be hastened by the adoption of measures like the ones above mentioned.

DAMAGES BY BIRDS GENERALLY.

Study of a number of cases of serious damage by birds leads to the conclusion that as a rule such damage is due to the concentration of a great number of birds within a limited area, usually of a single species or several closely allied ones. If the birds are seed eaters, they visit the grain fields and leave ruin and destruction in their path; if fruit lovers, they seek the orchard and play havoc with the crop. Instances of this kind are the raids of bobolinks in the rice fields of

the southeastern Atlantic coast, of the blackbirds in the grain fields of the Mississippi Valley, and of the linnets in the fruit orchards of California. It is seldom that complaints are made of birds in general; one or a few species are usually the culprits, the reason for which is evident—too many individuals of the same species in one locality eating the same things. But when many species are present in normal numbers, such a variety of tastes is to be gratified that no one kind of food is unduly drawn upon.

BIRDS THAT INJURE FRUIT IN CALIFORNIA.

When a fruit grower in northern California is asked what birds are most injurious to his crops, he almost invariably mentions first the linnet, or house finch; then successively the blackbird, the oriole, the grosbeak, and the thrush. Or, if his ranch is in a narrow valley or canyon, or near wooded hills, he may place the California jay or the quail after the linnet as the next worst enemy to fruit.

The writer is pleased to be able to testify to a healthy state of feeling on the part of the great majority of California fruit growers toward the bird population. While many of them stated that they still suffered loss, none advocated measures for the extermination, or even the material decrease, of birds. The feeling seems to be practically universal that birds as a class, notwithstanding their sins, still do more good than harm. "We can't get along without the birds," was the sentiment voiced by many and really indorsed by all.

HOUSE FINCH.

(*Carpodacus mexicanus frontalis.*)

The house finch, or linnet, has been perhaps the subject of more complaint on the score of destroying fruit in California than all other species of birds together. This bird occurs on the western coast of the United States from Mexico northward to Oregon, and extends eastward to the western edge of the Mississippi Valley. Except in the mountains, it is a resident throughout most of California, but in certain parts of the northern half of the State it disappears for a few months during the winter season. In the southern half and in the warm sheltered valleys of the north it is always present. It is a hardy, vigorous species, well able to take care of itself and maintain its ground wherever it obtains a foothold. It is a prolific breeder, raising several broods in the season, and apparently has no enemy (except man) that exercises any perceptible restrictive influence upon its increase and distribution. It takes kindly to the presence of man, and utilizes his improvements for shelter and food.

DESTRUCTION OF FRUIT.

Observations in orchards show that in the fruit season the linnet is not backward in taking what it considers its share of the crop, and as it spends much of the time there, field observations alone would lead to the conclusion that fruit was its principal article of diet. Examination of the stomach contents, however, proves that such is not the case, and when we find how small is the relative percentage of fruit eaten, it seems strange that its fruit-eating proclivities should have attracted so much attention. But it must be borne in mind that the bird is wonderfully abundant, which is one of the primary conditions necessary for any species to become injurious.

Like most fringilline birds, the linnet has a strong, conical beak, with which it can cut the skin of the toughest fruit and reach the pulp. While such an instrument is very effective in attacking fruit, this is evidently not the use for which nature primarily designed it. It is customary to divide passerine birds roughly into two groups, the hard-billed and the soft-billed species, the former of which are supposed to feed on seeds while the latter subsist upon fruit and insects. From the standpoint of this classification the linnet would appear to be most emphatically a seed eater, and examination of the contents of stomachs of the species confirms the correctness of this view. Seeds of plants, mostly those of noxious weeds, constitute about seven-eighths of its food for the year, and in some months amount to much more. In view of this fact it seems strange that the house finch has acquired such a reputation for fruit eating, and it can be explained only upon the principle already laid down that in the fruit districts the bird is too numerous for the best economic interests. While each house finch eats but a small modicum of fruit, the aggregate of all that is eaten or destroyed by the species is something tremendous.

Moreover, it must be noted that not all of the fruit destroyed is eaten. Only one peck from the strong bill is necessary to break the skin of the pear, peach, or cherry, and the fruit is spoiled; the linnet by no means invariably visits the same individual fruit a second time to finish it, but often attacks a fresh one at each meal. This is proved by the large number of half-eaten fruits, either on the tree or on the ground beneath.

In large orchards, however, complaints against the linnet are fewer than formerly. Here the damage is more widely distributed and consequently less noticeable than when confined to a few trees. It is probable that the area of orcharding has increased more rapidly than the linnets, so that the proportional injury is less. At present the chief complainants are the owners of small town lots, where a few trees are grown to supply fruit for home use. As linnets are usually

more numerous in villages and suburbs than in the country, trees in gardens are often entirely stripped.

INJURY TO FRUIT BUDS.

It is a little singular that formerly most of the complaints against the linnet were that it destroyed the buds and blooms of fruit trees instead of the fruit itself. Thus in 1886 Mr. R. P. Chandler, of Riverside, San Bernardino County, wrote:

The bird which is commonly known as the linnet, or crimson house finch, has been observed to do great injury to the apricot crops of this section by feeding on the fruit buds from the time they begin to swell until the trees are in bloom. Two years ago my entire apricot crop was destroyed by the above birds, and I took the opportunity to establish the facts of the case by shooting a large number for the purpose of examination. A great many of the birds that were shot had small bits of buds, etc., stuck on their bills by the gummy substances of the fruit buds. A further examination would invariably result in finding each and every bird's stomach filled with buds.

The same year J. C. Galloway, of Tustin, Cal., stated:

The common linnet does great injury to the buds of the apricot, eating out the center and destroying all the fruit buds on the tree in many cases, usually in January and February, in this latitude.

William Proud, of Rancho Chico, Cal., accuses the linnet of eating both buds and fruit. He says:

The burion, house finch, or linnet, is by far the most pernicious bird we have to deal with in the orchard. He arrives in March and immediately commences his ravages on the buds of the cherry, peach, plum, persimmon, etc. The first cherry showing a red cheek is sampled by this most rapacious little bird. Then comes the fruit of the apricot, peach, and fig. For the latter he shows a decided partiality. When the fruit crop is exhausted he immediately turns his attention to all kinds of millets, sorghum, Egyptian corn, and other small seeds.

As showing how destructive the bird is to fruit, especially in small orchards, the following is quoted from Dr. T. S. Palmer, then at Berkeley, Alameda County, Cal.:

The crimson house finch is the only bird that does any considerable damage to fruit. As soon as the cherries begin to ripen the birds keep close watch of the trees, and if the fruit is not gathered as soon as ripe they soon dispose of a large portion of it. In our garden there are about a dozen cherry trees of various kinds, and if not very closely watched, within a week or two from the time when the fruit first begins to ripen almost every tree will be completely stripped. Of course, in a large orchard the damage would not be so noticeable, but still might be considerable. Later in the season when the cherries are gone, the finches attack the plums and pears.

F. H. Holmes, of Rio Vista, Solano County, Cal., under date of September, 1886, states:

Our worst fruit pest is the crimson house finch, which, on account of its abundance and familiarity, it is impossible to scare off. They injure mostly cherries, figs, berries, peaches, and apricots. They often only peck each fruit

a little, and then the bees and wasps take hold and finish the work. * * * Birds that destroy the earlier fruits are generally regarded as the greater nuisance, particularly to the farmer who has not a very extensive orchard. Where fruit is handled as soon as it is in the proper condition, or for an orchard of from ten to one hundred acres or more, I have never seen these birds plentiful enough to do a great amount of damage. In some parts of the State I presume they might do more.

In regard to the habit of the linnet of eating ripe fruit, Dr. A. K. Fisher says:

In this valley [Owens], both at Independence and Lone Pine, the species [the linnet] was found to be very destructive to the ripened peaches during the middle of August. Flocks of birds occurred in the orchards, and in some places hardly an example of the ripe fruit could be found which was not more or less mutilated. A number of birds shot in the peach orchards at Lone Pine had little except the pulp of this fruit in their gullets or stomachs. It was known as the 'peach bird.' [a]

Examination of linnet stomachs does not reveal any very considerable number of blossom buds, and it is probable that but little of the alleged mischief to fruit blossoms is done by this bird. Moreover, it may be stated that in most cases budding by birds does little, if any, damage. It is only in very rare instances that birds take all the buds from a tree, or even enough to cause considerable loss. On the contrary, buds are usually superabundant, and budding, whether by birds or by man, is frequently beneficial, relieving the trees from excessive bearing and markedly improving both size and quality of fruit.

THE LINNET NATURALLY A SEED EATER.

Before the settlement of the Pacific coast region it is evident that the linnet must have subsisted almost entirely upon the seeds of plants growing wild in the valleys and canyons. With the advent of civilization two new articles of food were presented—grain and fruit. It would seem natural for the linnet, especially equipped as the bird is to extract the kernel of seeds, to have chosen the former, as did the blackbirds, doves, and some other species; but for some reason best known to itself it selected fruit. How much the character of the food had to do with the bird's choice it is impossible to say, but it is probable that attendant conditions greatly influenced the result. Grain is grown on large, open areas, with few or no trees to afford nesting sites, while orchards offer every inducement to linnets as a permanent residence. Moreover, much of the fruit-growing section of the State is divided into small holdings, each with a dwelling with accompanying barns, sheds, and other buildings that afford ideal homes for these birds. Having thus chosen the orchard

[a] North American Fauna No. 7, U. S. Dept. of Agric., p. 80, 1893.

Fig. 1.

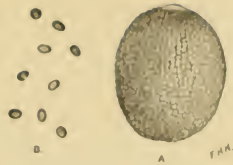

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

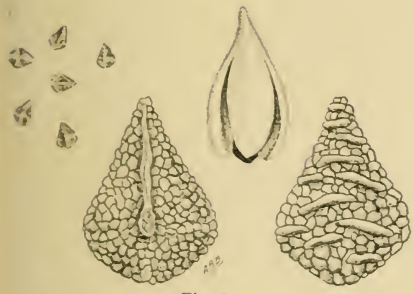

Fig. 6.

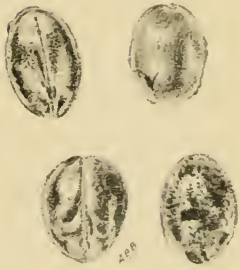

Fig. 7.

Fig. 8.

Fig. 9.

SEEDS OF COMMON WEEDS EATEN BY THE LINNET.

Fig. 1.—Napa thistle (*Centaurea melitensis*). Fig. 2.—Black mustard (*Brassica nigra*). Fig. 3.—Alfilaria (*Erodium cicutarium*). Fig. 4.—Knotweed (*Polygonum aviculare*). Fig. 5.—Tarweed (*Madia sativa*). Fig. 6.—Burweed (*Amsinckia tessellata*). Fig. 7.—Turkey mullen (*Eremocarpus setigerus*). Fig. 8.—Milk thistle (*Mariana mariniana*). Fig. 9.—Poison oak (*Rhus diversiloba*).

for its home it was only a matter of course that the bird should select as its secondary food the nearest available source of supply, namely, fruit. For seeds, which are to be regarded as the linnet's natural food, grow about the borders of orchards and by roadsides, and hence are readily obtained.

Although the great bulk of fringilline birds normally subsist principally upon seeds, at certain times, notably in the breeding season, they eat a considerable quantity of animal food, mostly insects. Moreover, their young while still in the nest are usually fed largely, and in some cases entirely, upon insects. Quite the contrary is true of the linnet. The adults eat only a small percentage of animal food, even in the breeding period, and feed their nestlings no more, perhaps less, than they eat themselves. In this respect the linnet is probably unique in its family. Such animal food as the bird does eat, however, is much to its credit. Plant-lice (Aphidæ), especially the woolly species, constitute a large portion of this part of the linnet's food; caterpillars and a few beetles make up most of the remainder.

It is, however, as a seed eater that the linnet stands supreme. Over 86 percent of its food for the year consists of weed seeds, and it is in this field, if anywhere, that the bird redeems itself from the odium of its other misdemeanors. When the immense number of linnets in California is taken into consideration, with the added fact that each one destroys several hundred seeds daily, most of which are potential weeds, it must be conceded that the bird renders a valuable service to agriculture, for the sum total of weeds so destroyed is enormous.

FOOD.

In the laboratory investigation of the food of the linnet 1,206 stomachs were examined, including 46 of nestlings. All were from California, and from points fairly well distributed over the State, with the exception of the northern quarter. The greater number were from the fruit-growing sections, so that the western coast region is better represented than the part east of the Coast Ranges. They were distributed through the year as follows:

January	88	August	118
February	35	September	123
March	186	October	108
April	80	November	25
May	74	December	54
June	167		
July	148	Total	1,206

In the first analysis of the food components the two principal elements are found to be: Animal matter, 2.4[a] percent; vegetable matter, 97.6 percent.

Animal food.—This brings into strong relief the linnet's sins of omission. Living in a country where constant war against noxious insects is necessary, the bird takes little or no part in the contest, and in return for benefits derived from man renders but slight service in this direction.

The small portion of animal food it takes, however, consists almost wholly of insects and a large proportion of it of plant-lice (Aphididæ), which from their small size do not attract the notice of many species of birds. They appear, however, to be the favorite animal food of the linnet, and it is noticeable that a large percentage of them are the woolly species. Many of the birds when killed had their beaks smeared with the remains of woolly aphides. As these insects are notoriously harmful to many trees and other plants, any bird that destroys them is a benefactor. It is to be regretted that the linnet should not indulge to a greater extent a taste so well directed. Were 25 percent of its food made up of woolly aphides the fruit it destroys would be well paid for. The other contingent of animal matter found in the linnet's stomach consists of small caterpillars and a few beetles, chiefly weevils. Most birds that feed on plant-lice eat also the ants that are usually in attendance upon them, but the only trace of ants or of other Hymenoptera in the stomachs of linnets was one ant's jaw. Grasshoppers, the favorite food of so many birds, were represented by a mere fragment in one stomach.

Vegetable food.—The most interesting part of the food of the linnet is the vegetable portion. This naturally falls into three categories: Weed seed, which amounts to 86.2 percent of the annual food; fruit, 10.5 percent; and other miscellaneous vegetable matter, 0.9 percent.

Fruit.—Fruit is represented in stomachs taken in January by a mere trace. This was probably of no value, only ungathered fruit or perhaps belated olives. In stomachs taken in February no fruit was found, but in ensuing months it appears in small quantities, increasing irregularly until August, when a maximum of 27.4 percent was eaten. In September a trifle less was taken than in August, and after that the quantity decreases until December, in which month a little less than 2 percent was eaten. In March the fruit amounted to about 6 percent, a quantity hard to account for except on the supposition that it was waste fruit left over from the previous year. The

[a] While percentages are sometimes given in fraction, it need not be assumed that extreme accuracy is intended; such figures must be taken as only an approximation to the truth.

amount eaten in this month is somewhat surprising in view of the fact that in April less than 2 percent was consumed, and it is not until June that the percentage becomes important. It is possible that the supply of weed seed of the previous year may be exhausted by March, when the new crop has not yet ripened; so waste fruit is taken for want of something better.

It is practically impossible to identify particular kinds of fruit in a bird's stomach unless characteristic seeds or stones are present. These are rarely eaten by the linnet, which seems to prefer orchard fruit. Cherries, apricots, peaches, and prunes appear to be the favorites. This choice arises, no doubt, from the character of its beak already described. While thrushes and other 'soft billed' birds prefer the smaller kinds commonly known as berries, which can be swallowed whole, the linnet attacks the larger kinds, which yield readily to its powerful beak. Linnets are particularly fond of small pears, like the Seckel, and often attack them even when they are hard, a fortnight or more before ripe. If undisturbed they will eat every one on a tree, leaving the core attached to dry and blacken in the sun.

A few strawberries and fewer blackberries or raspberries were the only cultivated small fruits that could be identified in the stomachs of linnets. A number of birds from the southern part of the State had fed freely on figs, identified by their seeds.

If the bird preferred an exclusive diet of fruit, there is no reason why its taste should not be gratified during the greater part of the year. When cherries are ripe in California linnets need eat nothing else. The cherry crop would be ample for all their wants, though perhaps not much would be left for marketing. The record, however, shows that in June, which is practically cherry month in the central part of the State, less than one-seventh of the linnet's food consists of fruit. Apricots are ripe in many parts of the State before the month closes, so that lack of fruit can not be urged as a reason why the bird should subsist so largely upon weed seed. In July apricots, peaches, and early figs are available, but still the linnet eats them only to the extent of one-fifth of its diet, and even in August and September, the months of maximum consumption, fruit constitutes only a little more than one-fourth of the food.

Weed seeds.—The greater portion of the linnet's food, as already stated, consists of the seeds of weeds, the most important of which are those of the Napa thistle, black mustard, Alfilaria, knotweed, and turkey mullen (see Pl. II, figs. 1, 2, 3, 4, 7), the total consumption of which for the year is 86.2 percent. This record is not excelled by that of any other bird studied, with the possible exception of the tree sparrow (*Spizella monticola*), whose food, however, consists largely of grass seed, much of which is useful. As there is an unaccountable

increase in the fruit eaten in March, so there is an unexplained decrease in the consumption of weed seed during that month. With that exception, the amount taken in each month decreases in a fairly regular series from a maximum of 99.8 percent in January to a minimum of 64 in August. From this month the quantity of seed in the stomachs increases steadily to December, when the record ends with 97.9 percent.

It seems probable that such a constant and persistent eater of weed seed would also eat considerable grain. Stomach records show that wheat was identified in one stomach, oats in three, and something very like the skin from kernels of corn in five. In this connection it can be said that if the linnet does not eat grain it certainly is not for want of opportunity. It is evident then that weed seed is taken by the linnet simply because it likes it.

SUMMARY.

It is natural to conclude that the food most frequently found in a bird's stomach is the kind preferred. Applying this test to the linnet we find that of the total 1,206 stomachs examined, 1,133, or 94 percent of all, held weed seed, and that 807, or nearly 67 percent of the whole, contained no other food. On the other hand, fruit was found in 297 stomachs, or 24 percent of the whole number, but only 38, or 3 percent of all, were entirely filled with it. In other words, there were only 63 stomachs that did not contain weed seed, while 909 contained no fruit.

The miscellaneous portions of the linnet's vegetable food amount to only about nine-tenths of 1 percent of the food of the year, and all was found in 28 stomachs. Stamens and other parts of flowers were found in 14 stomachs only, which does not indicate that the injury to fruit buds by the linnet is serious. One stomach contained a small leaf gall. Ten stomachs held matter denominated as rubbish, consisting of bits of dead leaves, rotten wood, etc., evidently swallowed unintentionally with other food.

From the foregoing it appears that, contrary to the statements and beliefs of many, the linnet is not a constant and persistent devourer of fruit. Examination of the contents of many stomachs shows that fruit is far from being its principal article of diet, and it is probable that what is taken is eaten for the sake of variety or for the juice. A far greater quantity of fruit is eaten by the cherry bird (*Ampelis cedrorum*) and by the robin (*Merula migratoria*), both of which occur in California.

PROTECTION OF FRUIT FROM LINNETS.

In the case of both these birds, however, the greater part of the fruit eaten consists of wild species, and this fact suggests a method

by which the California fruit grower may protect his orchards from the attack of the linnet—namely, by planting around orchards shrubs and trees the fruit of which will serve to attract birds away from the marketable kinds. There are many fruit-bearing shrubs and trees whose products, while worthless to man, are likely to prove more attractive to linnets than are the orchard fruits. That linnets will eat wild fruit appears from the fact that elderberries (Sambucus) were found in 49 stomachs, and their apparent partiality for cultivated fruits is readily explained by the fact that usually they are the only kinds obtainable.

FOOD OF YOUNG LINNETS.

Of the 1,206 stomachs of linnets included in this investigation, 46 were those of young birds taken from the nest. The young vary in age from birds 2 days old to those nearly ready to fly. In order to ascertain the exact difference, if any, between the food of the nestlings and that of the adults, the contents of these 46 stomachs were tabulated by themselves and the percentages of the various items of food calculated. The results show 2.4 percent of animal food to 97.6 of vegetable. The animal food consists mostly of the larvæ of a minute beetle which lives on decayed fruit, with a few plant-lice and one small fragment of a grasshopper, the only one found in any of the stomachs. The vegetable food consists entirely of weed seed, the most important of which are the following: Sunflower, bur weed, milk thistle, and poison oak. (See Pl. II, figs. 6, 8, 9.)

No fact connected with the food habits of the linnet is more surprising than this. The great body of the fringilline birds, though subsisting largely and in most cases almost entirely upon vegetable food in adult life, feed their young in the early stage of existence almost exclusively upon insects or other animal food, and begin to give them vegetable food only when nearly ready to leave the nest. It is doubtful if there is an exception to this rule so pronounced as the linnet. As calculated, the nestlings ate actually less animal food than their parents, but the difference is so small that it may be accidental.

ECONOMIC PLACE OF THE LINNET.

Admitting, as we must, that the orchardist has just grounds of complaint against the linnet on account of depredations upon fruit, the bird's claim to favorable consideration must rest upon its valuable services as a consumer of weed seed and upon its esthetic value. It is trim and pretty, has a sweet song, and in many ways is a pleasing adjunct of rural life—in fact, many Californians believe that the linnet, in spite of its sins of commission and omission, should be

protected. That the complete extermination of the species, even if possible, is not desirable will be readily allowed, but that a reduction of its present numbers would be for the general welfare can not reasonably be denied. Were it possible to destroy half the linnets in the fruit-growing sections of the State, there is no doubt that most of the complaints against the species would cease. As it is, the fruit grower must protect himself by such devices as are suggested by local conditions, and bear in mind that, while as an individual he may suffer, the bird, on the whole, is doing the State good service.

LIST OF SEEDS FOUND IN STOMACHS OF LINNETS.

Following is a list of identified seeds, with the number of stomachs in which each kind was found. The same kinds of seeds were of course contained in many more stomachs, but were so finely ground up as to be unidentifiable. It is not unlikely that in identifying the seeds specifically errors have been made, but it is believed that few, if any, of the generic identifications are erroneous. A few seeds were found which have not yet been identified.

Sedge (*Carex* sp.)	21
Sorrel (*Rumex acetosella*)	3
Knotweed (*Polygonum aviculare*). (Pl. II, fig. 4)	128
Catchfly (*Silene* sp.)	51
Chickweed (*Stellaria media*)	21
Spurry (*Spergula arvensis*)	14
Amaranth (*Amarantus retroflexus* et al.)	108
Calandrinia (*Calandrinia menziesi*)	2
Miner's lettuce (*Montia perfoliata*)	11
Wild turnip (*Brassica campestris*)	13
Black mustard (*Brassica nigra*). (Pl. II, fig. 2)	83
Wild radish (*Raphanus sativus*)	108
Geranium (*Geranium dissectum*)	3
Alfilaria (*Erodium moschatum*)	392
Alfilaria (*Erodium cicutarium*). (Pl. II, fig. 3)	
Yellow sorrel (*Oxalis corniculata*)	1
Turkey mullen (*Eremocarpus setigerus*). (Pl. II, fig. 7)	117
Poison oak (*Rhus diversiloba*). (Pl. II, fig. 9)	1
Burweed (*Amsinckia tesselata*). (Pl. II, fig. 6)	3
Nightshade (*Solanum nigrum*)	4
Western ragweed (*Ambrosia psilostachya*)	3
Sunflower (*Helianthus* sp.)	5
Mayweed (*Anthemis cotula*)	1
Groundsel (*Senecio vulgaris*)	21
Lesser tarweed (*Deinandra fasciculata*)	1
Tarweed (*Madia sativa*). (Pl. II, fig. 5)	5
Milk thistle (*Mariana mariniana*). (Pl. II, fig. 8)	3
Napa thistle (*Centaurea melitensis*). (Pl. II, fig. 1)	60

The following table shows the percentages of the various items of food of the linnet for each month of the year:

Table of percentage of food of the linnet for each month in year.

Month.	Number of stomachs examined.	Animal food eaten.	Vegetable food eaten.			
			Weed seed.	Fruit.	Miscellaneous.	Total vegetable food.
		Percent.	*Percent.*	*Percent.*	*Percent.*	*Percent.*
January	88	0.0	99.8	0.2	0.0	100.0
February	35	2.9	97.1	0.0	0.0	97.1
March	186	1.0	89.5	5.8	3.6	99.0
April	80	5.8	92.5	1.7	0.0	94.2
May	74	6.3	88.9	4.8	0.0	93.7
June	167	3.9	81.6	13.4	1.2	96.1
July	148	2.2	76.5	19.7	1.5	97.8
August	118	7.1	64.0	27.4	1.5	92.9
September	123	0.1	71.6	26.7	1.6	99.9
October	108	0.0	83.5	15.6	0.9	100.0
November	25	0.0	91.7	8.3	0.0	100.0
December	54	0.0	97.8	1.8	0.4	100.0
Total	1,206					
Average		2.4	86.2	10.4	0.9	97.5

WESTERN TANAGER.

(*Piranga ludoviciana.*)

The western tanager, like the robin, occasionally becomes a nuisance in the orchard. It breeds in the mountainous regions of California and northward, and as a rule is not common in the fruit-growing sections.

DAMAGE TO CHERRY CROP.

There are, however, times during migration when it fairly swarms in some of the fruit-raising regions, and unfortunately this sometimes happens just at the time when the cherry crop is ripening. The bird is a late breeder and does not seem to care to get to its nesting ground before the last of June or early July. It is thus enabled to begin in the southern part of the State when cherries are ripening there, and leisurely follow the ripening fruit northward. The year 1896 witnessed an incursion of these tanagers, when they swarmed over much of the State and destroyed a large part of the cherry crop.

Probably the best account of this occurrence is that of W. O. Emerson (published in the Condor, Vol. V, 1903, p. 64). Mr. Emerson says:

> One of the most wonderful occurrences of the movements of birds in the season of migration which ever came under my notice, took place at Hayward during May, 1896, when countless numbers of *Piranga ludoviciana*, or Louisiana tanagers, began to make their appearance between May 12 and 14. From the 18th to the 22d they were to be seen in endless numbers, moving off through the hills and canyons to their summer breeding range in the mountains. This continued till the 28th, and by June 1 only here and there a straggling member of

the flock was to be seen. They were first found feeding on early cherries, in an orchard situated along the steep bank of a creek, on the edge of rolling hills, well covered with a thick growth of live oaks, which faced the orchard on the east. To this thick cover they would fly, after filling themselves with cherries, and rest till it was time to eat again. This they would keep up from daylight to dark, coming and going singly all day, without any noise whatever being heard.

Two men were kept busy shooting them as fast as they came into the trees which lay on the side next to the oak-covered hills. * * * After the first week, I found on going here (May 17), that dozens on dozens of the birds were lying about. * * * Tanagers lay about everywhere, and no doubt many must have flown off to die in the bushes or on the hillsides. * * * I noticed one fact of the restriction of the tanagers to the orchards along the hill edges. None were found, so to speak, in the larger orchards about the town of Hayward. * * * Mr. H. A. Gaylord, of Pasadena, Cal., in a letter under date of June 16, 1896, states that "they were seen singly from April 23 to May 1. From this date up to May 5 their numbers were greatly increased, and by May 5 there was an unusually large number of them. Then for about ten days, until May 16, the great wave of migration was at its height. Tanagers were seen everywhere, and noticed by everyone. After May 20 they decreased in numbers, and by May 26 the last ones had left the valley." * * * He also says: "The damage done to cherries in one orchard was so great that the sales of the fruit which was left, did not balance the bills for poison and ammunition. The tanagers lay all over the orchard, and were, so to speak, 'corded up' by hundreds under the trees."

There must have been thousands of tanagers destroyed all through the path of their movement along the State, as they worked their way to the breeding grounds.

Here are two accounts of this great flight of tanagers—one from Pasadena, the other from Hayward, 330 miles farther north as the bird flies. The time taken by the tanagers in traversing this distance was only eight days, so it would appear that individual birds did not spend much time in the same orchard. Such sporadic flights are hard to account for. The tanagers are in California every year, and every year they migrate to their nesting grounds in spring and return in fall, but only at long intervals do they swarm in such prodigious numbers. Evidently the migration ordinarily takes place along the mountains where the birds are not noticed. It is possible that in some years the mountain region lacks the requisite food, and so the migrating birds are obliged to descend into the valleys. This would seem to be the most plausible explanation of the occurrence—that is, that the usual line of migration is along the Sierra Nevada, but some years, owing to scarcity of food, or other cause, the flight is forced farther west into the Coast Ranges, where the birds find the ripening cherries. The damage done by this species, however, is not confined exclusively to the rare occasions when they appear in such extraordinary numbers. R. H. Carr, of Redlands, southern California, wrote us in June, 1899:

Without examining any stomachs it is easy to report the value of the Louisiana tanager to the fruit growers near here. In the city they seem to keep

almost entirely on the Grevillea trees, sipping the sweet liquid that exudes from the blossoms. But the Andrews Brothers, whose cherry and apple ranch is in the upper Yucaipe Valley, report that the tanagers destroyed about $1,000 worth of cherries, being almost the entire crop. They used powder and shot liberally, but did not save the crop.

It is to be regretted that some of the stomachs of these tanagers were not saved, in order that the diet of the species might be ascertained with precision. The only material available for examination consists of 46 stomachs from various parts of the State, during the six months from April to September, inclusive. This number is entirely too small to afford positive data as to the regular food habits of the bird, but undoubtedly points in the right direction. Although the testimony of field observers shows that this tanager eats a good deal of fruit, analysis of the stomach contents proves that over 82 percent of the food for the six months indicated above consists of insects, and the remainder, nearly 18 percent, of fruit, with a mere trace of seeds of a conifer.

Insect food.—The largest item of the animal food is Hymenoptera, most of which are wasps, with some ants. Altogether they amount to 56 percent of the food for the six months, and in August they reach 75 percent. (They reach 92 percent in April, but only one stomach was taken in that month, so the record is not reliable.) Hemiptera stand next in importance, with 8 percent. They are mostly stink-bugs, with a few cicadas. Beetles amount to 12 percent of the food, of which less than 1 percent are useful Carabidæ. The remainder are mostly click-beetles (Elateridæ) and the metallic wood-borers (Buprestidæ), two very harmful families. The former in the larval stage are commonly known as wireworms, and bore into and destroy or badly injure many plants. The Buprestids, while in the larval stage, are wood-borers of the worst description. Grasshoppers were eaten to the amount of 4 percent, and caterpillars to the extent of less than 2 percent.

Fruit.—The greater part of the fruit eaten appeared to be the pulp of some large kind like peaches or apricots. One stomach contained seeds of elderberries; another the seeds and stems of mulberries, and two the seeds of raspberries or blackberries. Nearly all these stomachs were collected in the mountains, away from extensive orchards, but still the birds had obtained some fruit, probably cultivated.

SUMMARY.

It is evident from the testimony that great damage from this species occurs only at rare intervals and during the spring migration. The greatest losses occurred in May, 1896, when the damage to the cherry crop in certain localities was most disastrous. As, under ordinary circumstances, the greater part of the food of this bird consists

of insects, many of them harmful, the tanager has a fair claim to consideration at the hands of the farmer and even of the orchardist.

It is probable that means may be found to prevent, at least in part, the occasional ravages of the tanager on the cherry crop. The tanager, like the robin, prefers to swallow fruit whole, and as the latter takes small wild cherries in preference to the larger, cultivated kinds when both are equally accessible, it is probable that the tanager would do the same; and it is suggested that a number of wild cherry trees planted around California orchards might prove an economical investment for the orchardist.

SWALLOWS.

Swallows are the light cavalry of the avian army—always on the move, always on the skirmish line, ever gathering stragglers from the insect camps. They furnish another instance, and perhaps the most remarkable one, of change of habit induced by civilization. In eastern United States the bank swallow and the rough-wing are the only species that adhere persistently to their original nesting sites. In the West a third species may be added to these, the violet-green swallow; but there all the swallows are somewhat less domestic than in the East. It is probable, also, that some species, notably the barn swallow, are more abundant than when the country was unsettled, owing to the increased number of nesting sites. Supposing for a moment that the country was swept bare of buildings, where could all the barn swallows find suitable places to nest? The cliff swallows might discover enough overhanging cliffs upon which to attach their mud domiciles; the white-bellied and the martin, as formerly, might nest in the hollows of trees, but there are not caves enough east of the Mississippi River to afford nesting places for one-tenth of the barn swallows. In the far West they would fare better. When the country was first settled, barn swallows must have been confined to a few rocky cliffs and caves here and there along the seashore or in mountains. Now they live wherever man has erected a structure of any kind.

As is to be inferred from the movements of these birds, their food, with some curious exceptions, consists principally of insects caught in mid-air. For this reason all the species are migratory, except in the Tropics, for the food supply fails in regions where frosts prevail. As many insects that usually do not fly, periodically 'swarm,' they are often captured by swallows at such times in great numbers. Such is the case with ants and 'white ants' (Termitidæ), which most of the time are concealed in the earth or in logs, but at certain times 'swarm' in immense numbers. Many species of beetles that live in offal and ordinarily are not accessible to birds, in case of failure of

food, migrate in great numbers, and then are preyed upon by swallows, flycatchers, and other birds. The destructive cotton boll weevil is more or less active during the late summer and early fall months, and it has been learned that the swallows, as they pass through the cotton States on their way to their southern winter quarters, catch great numbers of them on the wing and so perform an exceedingly important service. Engraver beetles (Scolytidæ) have frequently been found in the stomachs of swallows. These insects live under bark, and generally are inaccessible to birds, except woodpeckers; periodically they migrate from the tree where hatched and matured to search for fresh pastures; at such times they are unprotected and fall easy prey to any fly-catching bird. Swallows are peculiarly adapted to capturing small insects in mid-air. While their bills are weak their mouths are wide, and their long wings enable them to fly swiftly and turn quickly, so that they sweep back and forth through a swarm of insects and gather them by hundreds.

Seven species of swallows, with several subspecies, are commonly found within the limits of the United States. Their food habits vary but little. All seven species occur in California, and this number includes one, the violet-green, that does not occur in the East.

Besides the swallows whose food will be discussed in detail in the following pages, a few stomachs of the tree swallow (*Iridoprocne bicolor*), the western martin (*Progne subis hesperia*), and the bank swallow (*Riparia riparia*) have been examined, but the number is entirely too small to be used as a basis for general conclusions were it not for the fact that their contents agree in all essential points with those of the other swallows, of which a greater number were available for examination. In fact, it may be said of all the members of the swallow family that they subsist upon practically the same kind of food, with slight variation from month to month. It may be laid down as a general rule that the food of all American swallows is derived from the following orders of insects: Coleoptera, Hymenoptera, Hemiptera, and Diptera, with a few individuals from one or two other orders, and an occasional spider. So far as present investigation has shown, 90 percent of their animal food is from the four orders named above, but the relative proportion of each varies somewhat with the different species and seasons. With one notable exception[a] the swallows take so little vegetable food that it may be passed by as a negligible quantity, and much even of the little eaten is probably swallowed accidentally.

After the above statements in relation to the food of the swallows, it is perhaps unnecessary to dwell upon the great value of these birds

[a] The tree swallow of the East (*Iridoprocne bicolor*) during its southern migration freely eats the berries of the bay-berry (*Myrica carolinensis*).

as insect destroyers. They do not consume any product of husbandry, and the worst that can be said of them is that they eat some useful insects with the harmful ones, though the former are in a very decided minority. This statement, however, applies to any and all insect-eating birds. It would be just as reasonable to expect a mower or reaper to cut grain and leave the weeds standing as to suppose that from the hordes of insects around us birds will select only the ones that are injurious to man and leave untouched those that are beneficial. Then, too, a superabundance of any species of insects, even beneficial ones, would be a nuisance. The service which swallows render is to prey upon the whole insect tribe and so to reduce the flood of insect life to a lower level where it may be more easily dealt with by man.

CLIFF SWALLOW.

(*Petrochelidon lunifrons.*)

In the Eastern States the cliff swallow has practically abandoned its original nesting sites under cliffs, and now nests under the eaves of houses and other buildings. The writer has counted 80 nests beneath the eaves of 1 barn. In California the bird has taken up with the new order of things to some extent, but has not entirely abandoned its old habits. It is a migrant and remains in the State for about six months only during the breeding season, which is the time when the bird does the most good.

The following discussion of the food of the cliff swallow is based upon the examination of 123 stomachs, representing every month from April to September, inclusive.

Vegetable food.—Vegetable food to the extent of 0.32 of 1 percent was found. In most cases this was simply rubbish taken accidentally, though it includes a few small seeds.

Animal food.—Of the animal matter the largest item is Hymenoptera. These insects formed over 39 percent of the total food; most of them were bees and wasps, and small parasitic species were identified in a number of stomachs; a few were ants. Unfortunately, many parasitic insects are eaten by birds that take their prey upon the wing, such as swallows and flycatchers. The fact is to be deplored, but in most cases the percentage is not large. Perhaps the most interesting insect among Hymenoptera eaten is the common honey-bee (*Apis mellifera*). Of these, 34 were identified, all contained in 11 stomachs, in one of which were 8 individuals. All were drones—that is, males. Not a trace of a worker bee was found. In two stomachs drones constituted the whole food and in several others the principal part. It is probable that most of them were taken when the queen made her marriage flight. So far as the writer has

been informed, bee keepers do not regard the destruction of drones as injurious to the swarm. In most cases drones are superabundant and instead of contributing to the food supply they are a drain upon it, so that the destruction of some of the surplus males is a positive benefit to the colony.

Hemiptera, or bugs, stand next to Hymenoptera in importance in the food of the cliff swallow. They form a little less than 27 percent of the whole diet, and are represented by eight families, namely, assassin-bugs, leaf-bugs, squash-bug family, stink-bugs, shield-bugs, tree-hoppers, leaf-hoppers, and jumping plant-lice.[a] All of these, excepting the assassin-bugs, are injurious to plants, and some of them are pests at all times. Of these, probably the leaf-hoppers (Jassidæ) are the worst. They suck the juices of plants, particularly grasses, which they infest by millions. They are said to have but few enemies, of which birds are the most effective. It is probable that they are captured by swallows when just skimming over the surface of fields, or are snatched from the tops of grass and weeds. They were found in 27 stomachs.

Leaf-bugs (Capsidæ) are a very large family of harmful insects, which feed almost entirely upon plants. Some species of this family are pests of the worst description. Leaf-bugs were contained in 43 stomachs. The other insects of this order are more or less harmful, but were not eaten so extensively.

Beetles of all kinds aggregate a little less than 19 percent. Of these, 2 percent were useful species, such as carabids and coccinellids. The others belong to 12 different families, most of which are harmful, some very much so. Among them were a number of aquatic species. These were probably captured by the swallows when flying just above the surface of the water. The principal flights of beetles do not occur during the day, but chiefly in early evening and at night.

Flies are eaten by cliff swallows to the extent of nearly 12 percent of the food. Most of these are the species commonly known as gnats, but one stomach contained a large horsefly (Tabanidæ). The gnats have a habit of swarming afternoons and evenings, when many are probably snapped up by swallows.

The remains of dragon-flies, lace-winged flies, ephemerids, and spiders make up the rest of the food, or a little more than 3 percent. As spiders do not fly, it may be asked how they were captured by the swallows. They probably were snatched from their webs or from the tops of weeds as the birds passed. Swallows pick up substances even from the ground, as is shown by the vegetable component of their food, and by other facts to be given presently.

[a] Plant-lice and scale-insects were not present, and this may be explained from the fact that their lives are passed mostly in a wingless condition.

FOOD OF YOUNG.

Among the stomachs examined were those of 22 nestlings, varying in age from 2 days to those just ready to leave the nest. They were taken from May 30 to July 2, inclusive. In order to ascertain if important differences exist between the food of the adults and that of the young, the contents of these stomachs were tabulated separately. Comparison shows little or no difference in the quantity of vegetable matter eaten by adults and young.

The animal matter in the food of the young is precisely of the same kind as eaten by adults, but the proportions are rather different. Hymenoptera are the largest item in the food of the young as well as of the parent birds, and amount to 42 percent for the former against 39 percent for the latter. Diptera stand next in importance, with 30 percent for the young against 12 percent for the adults. As these insects are mostly soft-bodied, it is the usual custom of birds to feed a greater proportion of them to the young. Hemiptera amount to a little more than 16 percent of the nestlings' food, while the adults eat them to the extent of nearly 27 percent. Beetles are fed to the young to the amount of about 10 percent, while the parents eat them to the extent of 19 percent. This again might naturally be expected, as most beetles are hard and less easily digested than flies and some other insects, and hence are less suitable food for young birds.

From the foregoing it is evident that the food of young cliff swallows does not differ in kind from that of the adults, but is distributed among the various orders of insects in somewhat different proportions. Hymenoptera and Diptera constitute nearly three-fourths of the diet, evidently because they are soft and easily broken up and digested. Beetles and bugs appear in the stomachs less frequently. While beetles are not extensively eaten, it is worthy of note that the variety is considerable, as representatives of no fewer than 10 species were contained in the stomach of one nestling. One stomach held a few bits of eggshell, and gravel was identified in two others. One of these contained 7 good sized gravel stones; the other, pieces of glass and gravel. The supposed function of gravel in the stomachs of birds is to assist in breaking up the food. That gravel should be given young cliff swallows when not taken by the adults is remarkable. The feeding of gravel to the young has been noted in the case of other species of swallows.

WESTERN BARN SWALLOW.

(*Hirundo erythrogastra.*)

The barn swallow is rapidly learning, not only that the structures built by man afford excellent nesting sites, but that the presence of

man is a sufficient protection against enemies. This species is generally distributed over the west coast region, but it is not so common as it is in the East, probably because of the relative scarcity of nesting sites. It is not improbable, however, that the end of the present half century will see the barn swallow as common throughout the whole of the region as it is in the East.

Eighty-two stomachs of barn swallows were examined, taken from April to October, inclusive, though April was represented by only two stomachs and October by one. While a greater number would have been desirable, the close resemblance of the food to that of the eastern birds, as shown by the contents of these stomachs, gives assurance that the results are reasonably reliable.

Vegetable food.—Practically no vegetable food was found in the stomachs examined. A single unknown seed was contained in a stomach taken in September.

Insect food.—So far as these 82 stomachs show, the western barn swallow subsists entirely upon insects, and it may be added that the same is true of the eastern bird.

The largest item of food is made up of Hemiptera of various families, amounting to nearly 39 percent of the whole. None of these insects was present in the two stomachs taken in April, but in every other month they constitute a large percentage of the stomach contents, and in September, when 38 stomachs were taken, they amount to 90 percent of the food for that month. Representatives of 8 families were identified, but the principal and most important ones are the leaf-bugs (Capsidæ), which were found in 44 stomachs.

Flies are next in importance, and amount to 32 percent of the food. Most of them belong to the family of the common house fly (Muscidæ), though probably there were others too badly mangled to be identified. No long-legged crane-flies (Tipulidæ), usually commonly eaten by birds, were found.

Hymenoptera constitute 18 percent of the food. Most of them consist of wasps and wild bees, but a few stomachs contained ants. One stomach had a drone honey-bee. Several birds had eaten parasitic species of Hymenoptera; a separate account was kept of these so far as possible, but the total amount summed up to only about one-fourth of 1 percent of the whole food.

Beetles aggregate nearly 10 percent of the whole, and belong to 13 families, with no preference for any. The bird probably snatches any and all beetles which it comes across. A few of the destructive engraver beetles (Scolytidæ) were found in 3 stomachs. Dragonflies and several unidentified remains constitute the remainder of the food and amount to a little more than 1 percent.

FOOD OF YOUNG.

The stomachs of two broods of nestlings of 4 each are included in the foregoing. The contents do not differ from those of adults except that they include a small percentage of gravel. Some of them contained also fragments of eggshell; one had a piece of mother-of-pearl (nacre), and one a small splinter of bone. It is curious that these indigestible substances should be so often fed to nestlings when the parent birds seldom take them.

VIOLET-GREEN SWALLOW.

(*Tachycineta thalassina lepida.*)

The violet-green swallow does not occur east of the Great Plains. Its general habits appear to be almost identical with those of its eastern relative, the white-bellied swallow.

The natural nesting site of both species was a hollow in a tree, and the western bird still adheres to the original habit and nests in the hollows of oaks and other trees, but the white-belly has to a great extent followed the example of so many of its relatives, and has taken to holes in buildings or to boxes put up for avian use.

In its food habits the violet-green exhibits no marked peculiarities; in fact it may be said that the food of the different species of swallows differs in degree rather than in kind. Stomachs of the violet-green have been collected in every month, except June, from March to September, inclusive, but only 7 were taken earlier than July. In that month, however, and the two following months 67 were obtained, a sufficient number to give a fair idea of the food at this season.

Insect food.—Insects constituted practically the entire contents of these stomachs. No spiders were found, and the only vegetable matter was a single seed, no doubt accidental.

As with the barn swallow, the largest item is Hemiptera, or bugs. These are represented by 10 different families, of which the leaf-hoppers (Jassidæ) were the most numerous, and the leaf-bugs (Capsidæ) next. Altogether they amount to 36 percent of the food.

Diptera stand next in importance, and in this respect also the violet-green resembles the barn swallow. They constitute nearly 29 percent of the food. Neither Diptera nor Hemiptera, however, are eaten as freely by the violet-green as by the barn swallow, and the deficiency is made up by Hymenoptera.

Hymenoptera amount to 23 percent of the food, and in the month of July were mostly made up of ants. Six stomachs taken on the same day and in the same locality were entirely filled with these insects. One taken at the same place on the following day was half filled with them, and this, with the exception of 1 percent

contained in one stomach in August, is the whole story of ants in the food of the violet-green. All of the other hymenopterous food consists of wasps and wild bees. In explanation of the fact that this bird eats ants freely for a short time and then eats no more, it may be stated that much of the time they are not obtainable. It is only when the insects are on the wing while swarming that the swallows can catch them, and then, being very numerous, they are eaten freely.

Beetles collectively amount to something over 11 percent of the food of the violet-green. Of these nearly 3 percent are Carabidæ, with a few coccinellids and carrion beetles, which must be reckoned as useful insects. The rest, over 8 percent, are of several families, all of which are more or less harmful. Three stomachs, collected at the same time in Carmel Valley, are of interest. They contained respectively 42, 45, and 40 percent of scolytid or engraver-beetles. This was in the region of the Monterey pine (*Pinus radiata*), and there is no doubt that these insects prey upon those trees, and probably were taken when migrating in a swarm to fresh foraging grounds. A few moths, with some unidentified insects, make up the remainder of the animal food, a little more than 1 percent.

CALIFORNIA SHRIKE.

(*Lanius ludovicianus gambeli.*)

The California shrike is common in parts of the Pacific coast region. At the present time fence posts and telegraph lines are the vantage points from which shrikes ordinarily scan the ground for prey, and in certain parts of the valley region it is unusual to glance along a line of wire and not see one or more within a short distance. It does not seem that trees and shrubs could ever have adequately supplied the need for lookout stations which is now filled by the poles and wires.

There seems to be a mysterious sympathy between the shrike and the little sparrow hawk, or perhaps their relations are inspired by jealousy. The sparrow hawk also occupies the poles and wires as a lookout for prey, and whenever a hawk stations himself upon one of the poles, there, at no great distance, is sure to be a shrike keeping close watch upon the movements of the larger bird. When the latter moves the shrike follows, and seems to aim to keep the other continually in view. Perhaps the shrike sees in the hawk a rival and considers that his preserves are being trespassed upon, though one would think there was room enough and prey enough for both. No case of actual conflict between the two has been observed—only this constant and unremitting surveillance on the part of the shrike.

The shrike resembles a bird of prey in form of beak and, to a certain extent, in food habits. Unlike the true birds of prey, however, its feet are not provided with talons for seizing prey and holding it securely while it is being torn into pieces. Whenever the shrike captures game that must be torn apart it presses it firmly down into a forked branch where it can readily be dissected.

The habit of the shrike of storing food apparently for future consumption has often been noticed. When food is abundant surplus captures are hung on thorns, sharp twigs, or, in recent times, the barbs of wire fences until needed; but as such occasions seldom arise, nine-tenths of this stored food is wasted so far as the shrike is concerned. Various more or less plausible explanations of this habit have been offered, but the simplest and most natural seems to be that much of the time the bird hunts simply for the pleasure and excitement of the chase, and as prey is often captured when hunger has already been satisfied it is stored for future use. It is the same instinct and lust for slaughter that prompts man to kill game that he can not use. The habit seems to be manifested also in a somewhat different way by the crow and magpie, which store up bits of glass or bright metal for which they can have no possible use. In the case of the shrike, however, the habit is useful to man if not to the bird, for most of its prey consists of noxious creatures, the destruction of which is a decided benefit.

The diet of the shrike and that of the sparrow hawk are almost exactly alike. It is a curious illustration of two species standing far apart systematically but by special modification approaching each other in food habits. The sparrow hawk has all the equipment of a carnivorous bird, but owing to its diminutive size its attacks are necessarily confined to the smaller kinds of prey, largely insects. The shrike, on the other hand, is a member of a group almost purely insectivorous, but it is so large and strong and has a beak so modified that in addition to its ordinary diet of insects, it is able on occasions to capture and tear apart small birds and mammals. While at present the two birds subsist upon much the same diet it is evident that their food habits have been modified in different ways. The natural food of the hawk family as a whole is vertebrate animals, to which some of its members, including our little sparrow hawk, have added a large percentage of insects. The normal food of the shrike is insects, to which on occasions it adds the smaller species of vertebrates.

Like the birds of prey and some other birds, the shrike habitually disgorges the indigestible portions of its food after the nutritive part has been digested. The bones and hair of mice are rolled into compact pellets in the stomach and finally disgorged. From examination of these a very good idea of the shrike's food may be gained.

A shrike of the eastern subspecies was kept in confinement for some weeks by the Biological Survey and notes made in regard to its food habits. A thorny bush was placed in the cage, and whenever the bird was given food in excess of its immediate wants it impaled the surplus upon a thorn, taking great pains to press it securely down. On one occasion a dead mouse was placed in the cage; it was at once seized and forced into the fork of the bush and was then torn piecemeal and eaten. Note was taken of the time when the last bit was swallowed, and a close watch kept for further results. In an hour and a half the bones and hair of the mouse were disgorged in the form of a neat pellet. Everything digestible had been stripped from the bones. A May-beetle (Lachnosterna) was eaten and the pellet containing the remains appeared in an hour and twenty minutes. At another time a ground beetle (Calosoma) and a stink bug (Nezara) were eaten and their remains appeared in forty minutes. As both of the insects are nauseous, at least to human smell and taste, it is possible that they may have been unacceptable to the stomach of the bird, and so were rejected before digestion was complete. On another occasion a second Calosoma and a moth were given, and their remains were regurgitated in an hour and fifteen minutes. These experiments show how rapid is the process of avian digestion.

In the investigation of the food of the California shrike 124 stomachs were examined. They were collected in every month, but the greater number were taken in the warmer months.

Vegetable food.—Animal food of all kinds amounts to 97.5 percent, or so nearly the whole that it is fair to suppose that the greater part of the 2.5 percent of vegetable matter present was swallowed unintentionally—that is, when sticking to something else. All of it was contained in 9 stomachs. Fruit appeared in 2 stomachs, seeds in 2, and rubbish in 6. Of these probably only the fruit was taken as food. One stomach was filled with elderberries to the amount of 84 percent of the contents, the other with the seeds of blackberries or raspberries to the extent of 13 percent. It thus appears that the shrike sometimes eats fruit.

Animal food.—The animal portion of the shrike's food may be divided into three parts: Insects, 83 percent; spiders and a few snails, etc., 2 percent; vertebrates, 12 percent.

Insect food.—In comparing the food of eastern subspecies of shrike and the one under discussion, we find that more insects are eaten by the western one. The figures for the eastern bird are: Insects, 68 percent; spiders, 4 percent; vertebrates, 28 percent. The difference is undoubtedly due to climate, the western bird being able to find insects all the year round, while the eastern one discovers very few during the winter. Insects probably are always preferred when obtainable.

Of insects eaten by the shrike, the largest item is Orthoptera—that is, grasshoppers and crickets—which amount to nearly 43 percent of the whole food. They are eaten in every month of the year, and in August and September reach nearly 70 percent. These are the normal grasshopper months, the ones in which Eastern birds enjoy their annual grasshopper feast. Ordinary grasshoppers form the greater part of this item of food, but a good many crickets are eaten, especially the brown and striped so-called wood crickets. One group of these is particularly noticeable—a group of large soft-bodied monsters of the genus Stenopelmatus, many of which live under dead leaves, stones, and rubbish, and do not often voluntarily show themselves by the light of day. It seems strange that the shrike, a lover of open and sunshine, manages to discover these creatures. They are sometimes called 'sand-crickets,' and perhaps at times come out into the open, but the writer has never seen one except when dug from under rubbish. It is not known whether these insects are harmful or beneficial, so the shrike's consumption of them has no economic interest. It is quite the contrary, however, with regard to grasshoppers, for they are harmful in all stages of existence, and the shrike is directly beneficial to the farmer to the extent that it destroys them.

Beetles collectively are second in importance in the shrike's diet. They amount to 16 percent of the food, but of this about 7 percent are the useful ground beetles (Carabidæ) and carrion beetles (Silphidæ). The rest are mostly harmful. The presence of these last is a curious point in this connection. These insects are probably useful, and while no great number of them are consumed, it seems rather strange that they are eaten at all. The surroundings of these beetles are not pleasant, and they do not generally serve as food for birds except crows and other garbage hunters. Is it possible that the shrike finds them on the game which it has hung on twigs or thorns? They were noted in 8 of the 124 stomachs, and three species were identified. Most of the beetles eaten by the shrike are of the larger species, but it does not disdain small game, and quite a number of small leaf-beetles and weevils were among the others.

Ants and wasps amount to something more than 11 percent in the diet of the shrike. Naturally they are mostly eaten in the warmer months, and the wasps far outnumber the ants.

Moths and caterpillars are taken to the extent of somewhat more than 7 percent, and seem to be a regular though small component of the food. Unlike the wasps, the greater number of these were eaten in the colder months. One stomach was entirely filled with the remains of 15 moths, a most unusual occurrence, for adult Lepidoptera do not form a large element of the food of any bird yet investigated.

Bugs and flies are eaten occasionally. The stomachs taken in February contained a good percentage of Hemiptera, and so did those

collected in July. In one stomach remains of robber-flies (Asilidæ) were detected. This is a family of large predaceous flies, some species of which are said to prey upon honey-bees. These two orders and a few other odd insects constituted 5 percent of the food.

Spiders and several other kindred creatures form less than 2 percent of the food, but though not eaten in great numbers they appear in a good many stomachs. In one stomach was found one of those bristly and uncanny monstrosities of the order of jointed spiders (Solpugida). It is wonderful that any bird should attack one, still more that it should eat it, as it would seem to be about as palatable as a paper of pins. The lingual ribbon, or tongue, of a snail was found in one stomach, and bits of what appeared to be the limbs of small crustaceans in several. They did not amount to a noticeable percentage.

Vertebrates.—The vertebrate part of the shrike's food amounts to a little more than 12 percent, and consists of the remains of small mammals, birds, and lizards. Mammals were found in 4 stomachs, birds in 2, and lizards in 12. Neither of the birds could be identified further than that both were small song birds. Of the mammals, one was a pocket mouse (Perognathus), one a young field mouse (Microtus), and one a shrew (Sorex). The fourth mammal could not be identified, as there was little left except hair. The lizards were not recognizable either generically or specifically, as the remains consisted only of bones and scales. From an economic standpoint, lizards are useful animals, as they subsist on insects. The same is true of birds, so that in destroying birds and lizards the shrike is doing harm. Fortunately, it does not eat many birds. The destruction of the mammals is an unmixed blessing, except, perhaps, in the case of the shrew (Sorex), which is largely insectivorous. Even if all the above vertebrates were useful the score against the shrike would not be a very heavy one and would not outweigh the value of its services in destroying grasshoppers. In the writer's field experience with the shrike only one attempt to capture a vertebrate animal was observed. In this case the shrike was seen to plunge into a thicket of weeds in pursuit of a brood of tiny quail, but a few seconds later it emerged in a great hurry, closely followed by the irate cock quail. As a matter of fact, the noxious mammals eaten both by the eastern and western shrikes far outnumber the birds, and when to the former are added harmful insects the balance is very largely on the credit side.

FOOD OF YOUNG.

No nestlings of shrikes were at hand for investigation, but the stomachs of two young just out of the nest were examined. Both

were filled with beetles, ants, wasps, and crickets. In a bird so thoroughly insectivorous as the shrike it is not probable that the food of the nestlings differs essentially from that of adults.

As a feature of the landscape and as lending animation to rural scenes the shrike in California is a pronounced success, and when one sees him jauntily balancing on a telephone wire it is pleasant to reflect that in his economic relations he is as admirable as he is from the esthetic point of view.

VIREOS.

The vireos are a group of rather small tree-haunting birds of plain colors, modest habits, and sweet but unobtrusive voices. One or the other of the several species inhabits pretty much everything in the way of a tree from the monarchs of the forest down to the humblest underbrush. In thickly settled country vireos inhabit gardens, orchards, and city parks, and shade trees along the village streets. Most of them are migrants, and leave the United States in winter, but a few remain on the Pacific coast throughout the year. Their food consists largely of insects, though a little fruit and some seeds are occasionally eaten.

In the insect diet of the vireos there is one element which constitutes a bar sinister on an otherwise brilliant escutcheon. All the species investigated show a decided taste for ladybirds—that is, coccinellid beetles. No other genus of birds, nor any single species (with one possible exception), so far has been known to manifest such fondness for these useful insects. In California the destruction of ladybird beetles is perhaps a greater crime than it would be in almost any other section of the country, for here the bark scales and plant-lice upon which these beetles feed are very destructive, and every device for their extermination has been employed, even to importing several foreign species of these predatory beetles.

Time was when the devastation of the San Jose scale and several other species of scale insects threatened the fruit industry of California, and there can be no reasonable doubt that the coccinellid beetles of both the imported and native species were largely instrumental in checking the spread of these pests. It is to be remarked that these beetles are wonderfully abundant in California, probably more so than any other family. The writer found them upon corn, weeds, grass, and bushes, often where apparently there was none of their natural food. In mitigation of the vireos' habit of eating ladybirds all that can be said is that where there is such a superabundance of the insects the damage is minimized.

The writer is glad to be able to add that besides the coccinellids, vireos eat many harmful insects, among which are the black olive

scale. Here, then, is an instance where the bird eats the useful beetle and also its noxious prey. As there is nothing to indicate that the bird exercises a choice between them, we must infer that it eats both whenever it finds them. It eats the beetles and the food (scales) upon which they feed. From this point of view also it must be allowed that the harm done by the vireos in eating coccinellids is offset to some extent.

WESTERN WARBLING VIREO.

(*Vireo gilvus swainsoni.*)

One hundred and ten stomachs of the warbling vireo have been examined. They were collected during the seven months from April to October, inclusive, and though hardly as many as could be desired, they probably furnish a fair idea of the food during that portion of the year.

Vegetable food.—Insects, with a few spiders, amount to over 97 percent of the diet, leaving less than 3 percent of vegetable matter, practically all of which was taken in August and September; it consisted of wild fruit (elderberries), a few seeds of poison oak, a few other seeds, and some rubbish.

Animal food.—Of the animal food the largest item is Lepidoptera; that is, caterpillars, moths, and the like. These amount to something more than 43 percent of the whole. Caterpillars make up the great bulk of this portion of the food and are a very constant and regular article of diet. Fewer are eaten in July and August and more at the beginning and end of the season. In April they amount to over 82 percent of the food of the month. Pupæ of codling moths were identified in four stomachs, and minute fragments probably of the same were found in several others. A few adult moths also were found, but the species could not be identified.

Hemiptera are the next most important item of diet, and amount to 21 percent. They consist of stink-bugs, leaf-bugs, leaf-hoppers, spittle-insects, tree-hoppers, and scales. The last were the black olive species (*Saissetia oleæ*). Coccinellid beetles, or ladybirds, were eaten to the extent of over 19 percent of the whole. None was in the stomachs taken in October, while the greater part (over 63 percent) was contained in those obtained in July. The species belong to the genera Hippodamia and Coccinella, which are larger than those of the genus Scymnus selected by the warblers. Other beetles, mostly harmful species, amount to more than 7 percent.

Hymenoptera, which are an important food of the warblers, are conspicuous by their absence in the stomach of the warbling vireo. A little more than 1 percent represents the sum total. They consist of a few ants and an occasional wasp.

A small number of flies, grasshoppers, and dragon-flies make up a little more than 3 percent of the miscellaneous insects. Spiders were eaten to somewhat less than 2 percent.

CASSIN VIREO.

(*Vireo solitarius cassini.*)

This is another of the tree foragers living in summer in orchards, canyons, and forests.

Its food consists of the same elements as that of the last-described species, but in somewhat different proportions. Forty-six stomachs were examined, taken in every month from April to November. They afford at least a fair indication of the food for those months.

Vegetable food.—The vegetable food, which was only a little more than 2 percent of the total, was made up of leaf galls, seeds of poison oak, and a few bits of rubbish. Not a trace of fruit was found.

Animal food.—The animal matter amounts to nearly 98 percent of the whole. Hemiptera are the largest item and amount to nearly 51 percent. The various families represented are those of the squash-bugs, leaf-bugs, stink-bugs, shield-bugs, leaf-hoppers, tree-hoppers, the jumping plant-lice, and scales. The latter are represented as usual by the black olive scale, which was contained in four stomachs. Caterpillars, with a few moths, are next in importance and form more than 23 percent of the whole food. They were eaten in every month and are evidently a favorite diet.

Hymenoptera are eaten much more largely by this species than by the last. They amount to over 7 percent, and are mostly wasps, with a few ants. This record, however, is likely to be modified by further investigation.

Ladybird beetles were eaten to the extent of a little less than 6 percent, which is quite reasonable as compared with the record of the warbling vireo. It is, however, much greater than that of any bird outside the present genus, except the pygmy nuthatch, and in the case of that bird the evidence is too meager to be accepted at its face value. Other beetles amount to a little more than 3 percent of the food, and are mostly weevils and small leaf-beetles (Chrysomelidæ). A few flies, grasshoppers, and other insects amount to somewhat more than 2 percent, and these, with 4 percent of spiders, make up the remainder of the animal food.

SUMMARY.

In glancing over this record of the Cassin vireo it appears that bugs are the favorite food, as shown by the numbers consumed; but caterpillars, though second in quantity, are eaten with greater regu-

larity and appear in the food of every month. The consumption of ladybirds is very moderate for a vireo, and on the whole the bird probably does not do much harm in this way. All the other beetles are harmful, as are most of the other insects which compose the bird's food.

HUTTON VIREO.

(*Vireo huttoni.*)

This species is a resident of most parts of California west of the great interior valley. In food habits it does not differ remarkably from the foregoing, but the various elements of its food are in slightly different proportions.

Vegetable food.—Examination of 54 stomachs shows that less than 2 percent is composed of miscellaneous articles of vegetable origin. One stomach contained a few seeds of elderberries, two contained those of poison oak, and these with a few galls and some rubbish make up the whole of this part of the food. It would seem that with most of the vireos vegetable matter is taken accidentally, or possibly experimentally to see how it tastes, rather than as an approved article of diet.

Animal food.—Of the 98 percent of animal food the largest item is Hemiptera, as is the case with many of the vireos, titmice, and gnatcatchers. These insects amount to 49 percent of the food of the present species, and are represented by the following families: Assassin-bugs, leaf-bugs, stink-bugs, leaf-hoppers, tree-hoppers, jumping plant-lice, and bark scales. These last consist, as is so often the case, of the black scale, which appeared in 8 stomachs. Caterpillars, with a few moths and cocoons, are next in importance, and constitute over 22 percent of the food. These two items not only make up more than two-thirds of the diet, but are eaten with great regularity through the year and seem to be the staples of the bird's food.

Beetles, collectively, amount to nearly 11 percent. Of these 8 percent are ladybirds, somewhat more than were eaten by the Cassin vireo, but only half of the amount eaten by the Swainson vireo. The remaining beetles, less than 3 percent, were largely weevils, among which a few engravers (Scolytidæ) could be distinguished. Hymenoptera, including both wasps and ants, form about 7 percent of the food. Among them several parasitic ones were identified, but there were not enough to be of any great economic interest. A few miscellaneous and unidentified insects amount to nearly 5 percent of the food. Flies and grasshoppers make up a part of this, but they are only rarely eaten. Spiders are consumed regularly but sparingly. They amount to a little more than 2 percent.

OTHER CALIFORNIA VIREOS.

Several other species and subspecies of vireos occur in California, but in the general character of their food they agree closely with the foregoing.

BEETLES FOUND IN STOMACHS OF VIREOS.

Coccinella t. californica.
Hippodamia convergens.
Scymnus spp.
Agrilus spp.
Crepidodera helxines.
Gastroidea viridula.
Blapstinus spp.
Apion cribricollis.
Balaninus spp.
Copturodes koebelei.

WARBLERS.

(Mniotiltidæ.)

The warblers, or more properly the wood warblers, to distinguish them from the warblers of the Old World (Sylviidæ), are a large family of rather small and often brightly colored birds. For the most part they inhabit woods and shrubbery, and while some of them obtain their food from the ground they seldom wander far from trees and bushes. The species and subspecies are so widely distributed that, excepting the deserts, there are no very extensive areas within the boundaries of the United States that do not have their complement of these interesting birds. Their food consists largely of insects, and they subsist upon species which frequent the leaves and trunks of trees. Wasps and flies (Hymenoptera and Diptera) form a large portion of their diet, and as these insects are the best of fliers a considerable portion of them are taken on the wing. The warblers probably eat more of these elusive insects than does any other family of birds except the flycatchers (Tyrannidæ) and the swallows.

Upward of 75 species and subspecies of warblers are known within the limits of the United States, and a majority of these occur in the West, though perhaps they are not so abundant individually as in the Mississippi Valley and Appalachian region.

The genus Dendroica, as the one best exhibiting the characteristic traits of the group, may be taken as the type of the family. There are about 30 species and subspecies of the genus in this country, and the ones whose food is discussed in the following pages occur in California and on the Pacific coast generally.

In a résumé of the food of the warbler family one is impressed with the general noxious character of the insects which compose it. The order of Hemiptera, commonly called bugs, contains some of the worst insect pests that afflict mankind. Moreover, from their small size and unobtrusive habits they are not eaten by many of the larger birds and are difficult to exterminate by the devices of man. But in some of their multiple forms they are preyed upon by the warblers

AUDUBON WARBLER (DENDROICA AUDUBONI).

to an average extent of more than 25 percent of the whole food. Most of the other insect food, also, is either of a noxious or neutral description, and the vegetable portion is so small that it may be disregarded. There is probably no finer tribute to the beneficial character of these birds than that of Dr. Elliot Coues, who says:

With tireless industry do the Warblers befriend the human race; their unconscious zeal plays due part in the nice adjustment of Nature's forces, helping to bring about the balance of vegetable and insect life, without which agriculture would be in vain. They visit the orchard when the apple and pear, the peach, plum, and cherry, are in bloom, seeming to revel carelessly amid the sweet-scented and delicately-tinted blossoms, but never faltering in their good work. They peer into the crevices of the bark, scrutinize each leaf, and explore the very heart of the buds, to detect, drag forth, and destroy these tiny creatures, singly insignificant, collectively a scourge, which prey upon the hopes of the fruit-grower and which, if undisturbed, would bring his care to naught. Some Warblers flit incessantly in the terminal foliage of the tallest trees; others hug close to the scored trunks and gnarled boughs of the forest kings; some peep from the thicket, the coppice, the impenetrable mantle of shrubbery that decks tiny watercourses, playing at hide-and-seek with all comers; others more humble still descend to the ground, where they glide with pretty, mincing steps and affected turning of the head this way and that, their delicate flesh-tinted feet just stirring the layer of withered leaves with which a past season carpeted the ground.[a]

Following is a list of insects, mostly beetles, identified in the stomachs of the warblers examined. A number of these had been eaten by nearly every species:

COLEOPTERA.

Coccinella t. californica.
Scymnus pallens.
Scymnus marginicollis.
Scymnus sp. nov.
Microlipus laticeps.
Melanophthalma americana.
Aphodius rugifrons.
Diachus auratus.
Gastroidea cyanea.
Diabrotica soror.
Crepidodera helxines.
Epitrix parvula.
Bruchus pauperculus.
Blapstinus pulverulentus.
Notoxus alamedæ.
Anthicus difficilis.
Diodyrhynchus hyturoides.
Apion vespertinum.
Onychobaris insidiosa.
Balaninus sp.

HEMIPTERA.

Saissetia oleæ.
Aspidiotus rapax.

AUDUBON WARBLER.

(*Dendroica auduboni.*)

(Plate III.)

The Audubon warbler is well distributed over the Pacific coast region, breeding in the mountains and descending in winter to the valleys and plains of California. It is one of the most abundant

[a] Birds of the Colorado Valley, p. 201.

species, and may be considered as typical of the genus, especially in the matter of food. In the winter season it is a frequenter of orchards, gardens, and dooryards where it pursues its business of insect hunting with a persistent assiduity worthy of all praise. At this season it is very familiar and easily approached.

In investigating the food of the Audubon warbler 383 stomachs have been examined. They were taken from July to May inclusive. Geographically they are distributed from the San Francisco Bay region southward to San Bernardino, and probably give a fair idea of the winter diet of this bird in California. The food consisted of nearly 85 percent of animal matter (insects and spiders) and a little more than 15 percent of vegetable.

Animal food.—The largest item of animal food is Hymenoptera—wasps and ants—which aggregate a little more than 26 percent of the whole. By far the greater number of these are ants, and as plant-lice also are eaten to a considerable extent, it is probable that many of the ants are species that take care of the lice. The other members of this order are mostly rapid fliers, so the inference is that they were caught on the wing. The greater number were eaten in the fall and spring months. In our record May appears as the month of least consumption—6 percent. August is the month of greatest consumption—61 percent. This record, however, probably is unreliable, as but one stomach was taken in this month. A few were identified as belonging to parasitic species.

Flies (Diptera) are represented in the stomachs of the Audubon warbler to the extent of a little more than 16 percent, or one-sixth of the whole food. This is one of the largest, if not the very largest, record of this order of insects eaten by any bird except some of the swallows. Even the so-called flycatchers do not eat so many flies as this warbler—in fact, the name 'wasp-catchers' would be much more appropriate for that family. The flies eaten by the Audubon warbler must have been caught in mid-air, for flies as a rule do not allow themselves to be captured without at least attempting to escape. These insects are so soft-bodied that it is not often possible to determine more about them than that they are Diptera. Two families were identified—Muscidæ, the family of the common house fly, and Tipulidæ, or crane-flies, the long-legged mosquito-like creatures otherwise known as "daddy-long-legs." Most of the Diptera, however, are the smaller species, such as gnats, which fly in swarms, and being rather sluggish are more easily captured. They are eaten with remarkable regularity during the whole season, with no decided decrease in the winter months—in fact, more were eaten in January than in either September or April. March is the month of maximum consumption, when Diptera constitute over 54 per cent of the whole food.

Bugs collectively amount to nearly 20 percent, of which a little more than 4 percent are scales and plant-lice. The black olive scale (*Saissetia oleæ*) and another species (*Aspidiotus rapax*) were found in 15 stomachs. Plant-lice (Aphididæ) were contained in 39 stomachs, and from the numbers eaten appear to be favorite food. Several stomachs were entirely filled with them, and the stomachs in which they were found contained an average of 71 percent in each. The remainder of the hemipterous food, more than 15 percent, is made up of stink bugs, leaf-hoppers, and tree-hoppers, with a considerable residue of other remains not further identified. Bugs, as a whole, are eaten rather irregularly, and the greater number are eaten in the fall months, after which the number consumed gradually decreases. Caterpillars are eaten rather regularly by the Audubon warbler, but not in great numbers. They amount to nearly 14 percent of the food of the season, though this figure includes a few moths and chrysalids. Some cocoons of tineid moths were in several stomachs.

Beetles of all kinds aggregate something more than 6 percent of the whole diet. They belong to several families, but the snout-beetles are most prominent. The others belong to about a dozen families, and, except a few carrion and ladybird beetles, are injurious. A few insects other than the above and some spiders, in all a little less than 2 percent, make up the rest of the animal food.

Vegetable food.—The vegetable food of the Audubon warbler consists of fruit, weed seed, and a few miscellaneous substances. As the bird does not visit the fruit-growing regions during the fruit season, it is not chargeable with injury to cultivated crops. Almost all the fruit eaten is wild and of no value, though in the fall it probably feeds to some extent upon various belated products of the orchard. The total of fruit for the season is less than 5 percent, of which the greater amount is eaten in the autumn and early winter, after which the quantity is unimportant.

The most prominent item of vegetable diet, however, is weed seed. This is eaten to the extent of a little more than 9 percent of the whole food, and is taken in almost every month of the bird's stay, the greater quantity in winter. Something more than 31 percent was eaten in December, 22 in January, and 31 in February, after which it decreases regularly to April. One of the most important seeds eaten by the Audubon warbler is that of the poison oak (*Rhus diversiloba* (Pl. II, fig. 9). In most cases the whole seed is not eaten by this bird, but only the waxy outer coating, which is easily identified by certain woody granules which it contains; hence the bird does not aid in the distribution of these noxious plants. The remaining vegetable food, amounting to less than 2 percent, consists principally of rubbish.

SUMMARY.

It must be evident to the most casual reader that this bird is a valuable asset in the orchard and garden. The great bulk of its food, both animal and vegetable, is composed of elements the elimination of which from the farm is a benefit. As has been elsewhere pointed out, the destruction of insects during winter or in early spring is more useful than in the height of the midsummer abundance, for in spring the progenitors of the season's broods are destroyed and with them the possibility of thousands of progeny.

MYRTLE WARBLER.

(*Dendroica coronata.*)

This is another winter visitant in California. Only 10 stomachs of this species have been examined, but the contents show the predominant food characteristic of the genus. There is one point, however, which is worthy of passing note. One of these stomachs was completely filled with greedy scales (*Aspidiotus rapax*), with the exception of a small fragment of a beetle; another contained remains of the black olive scale, and still another some scales not identified.

TOWNSEND WARBLER.

(*Dendroica townsendi.*)

The Townsend warbler, like the Audubon, summers in California only in the mountains. During the migration and in winter it visits the valleys. Like other members of the family it is an insect eater almost exclusively, and does not eat fruit or other farm products. Thirty-one stomachs were taken in the four months from October to January inclusive, in the region from Pacific Grove to Watsonville.

As our stomach examinations disclose the fact that the food of this warbler agrees closely with that of others of the same group, a fair idea of the diet for the above months is obtained.

Animal food.—The animal food consists of insects and a few spiders, and amounts to over 95 percent of the food during the time specified. Of this, bugs make up 42 percent, mostly stink-bugs (Pentatomidæ) and a few leaf-hoppers and scales. The former appear to be a favorite food. Although these insects are eaten with considerable regularity by most of the warblers of this group, they are not usually taken in great numbers, but the Townsend warbler eats many, and several stomachs were entirely filled with them.

Hymenoptera, consisting of both wasps and ants, are eaten to the extent of 25 percent of the food. Most of them are winged species. Perhaps the most striking point in the food of this bird is the great

number of weevils or snout-beetles represented. They amount to over 20 percent of the food, while all other beetles form less than 1 percent. The greater number of these insects were of the species *Diodyrhynchus hyturoides*, a weevil which destroys the staminate blossoms of coniferous trees. Five stomachs contained, respectively, 68, 65, 53, 50, and 35 of these beetles, or 271 in all. Moreover, each of these stomachs contained fragments which could not be satisfactorily identified; probably these were the same species, so that the total contained in the 5 stomachs is probably nearer 300. Several other stomachs contained fewer of these weevils. Representatives also of another family of snout-beetles very destructive to timber were present in a few stomachs. These were the engravers (Scolytidæ), which lay their eggs beneath the bark of trees, where they hatch, and the larvæ bore in every direction. Caterpillars and a few miscellaneous insects and some spiders make up the remainder of the animal food.

Vegetable food.—The vegetable matter, which amounts to less than 5 percent of the whole, consists of a few seeds and leaf galls. As the galls in most cases contained small larvæ it is a question if they should not be reckoned as animal food.

SUMMARY.

While this can be considered as only a preliminary study of the food of the Townsend warbler, the thoughtful reader can not fail to be impressed by the fact that this bird exhibits some very valuable economic traits, especially in its relation to the forest. The stomachs containing the pine-eating weevils were from birds killed in the pine forests of Pacific Grove, near Monterey, as also were those containing the engraver beetles. Of the 30 stomachs examined, 19 held the remains of weevils, from which it would appear that these insects are preferred as an article of food. As this group of beetles contains some of the worst pests of the forest and orchard, any bird that eats them so freely must be considered as performing a most welcome service.

SUMMER WARBLER.

(*Dendroica æstiva* subspp.)

The summer warbler, yellow warbler, or summer yellowbird, as it is variously called, is represented in the West by two subspecies, one of which visits California only as a migrant. The other, which does not differ essentially from the eastern form, is a rather common summer resident throughout the valley and foothill regions. In the East this bird is fairly domestic in its habits, and may often be seen about gardens and orchards, or in rose bushes nearer the house. In California it is not quite so familiar, but is becoming so and probably will

soon acquire the habits of its eastern relative. From the material at hand this warbler appears to be even more exclusively insectivorous than the species last discussed. This may arise from the fact that it stays in the fruit districts during summer, when insects are most numerous; but it must be remembered that this is also the season when fruit and vegetable food generally are most abundant.

William Prond, of Chico, Butte County, thus recounts the efficient service of this and other warblers:

> On Rancho Chico is a fine collection of roses, all of which are more or less liable to attacks from *Aphis rosea*, but are perfectly free from other insects. I attribute this to the protection of small birds, among the most active of which are *Dendroica æstiva*, * * * *Helminthophila celata*, *Regulus calendula*.

The following statements in regard to the food of the summer warbler are based on the examination of 98 stomachs, all collected from April to October, inclusive.

Animal food.—The animal food, composed entirely of insects and a few spiders, amounts to over 97 percent. The largest item is Hymenoptera, which amounts to over 30 percent, about half of which are ants. The remainder are small bees and wasps, some of which are probably parasitic species, though none were positively identified. The insects of this order must be favorite food, as they are eaten with remarkable regularity and constitute an important percentage of the diet in every month represented. Caterpillars, with a few moths, aggregate over 18 percent. The greater number are eaten in spring and early summer, but in fall they give place to other insects.

Beetles form nearly 16 percent of the diet, and embrace about a dozen families, of which the only useful one is that of the ladybirds (Coccinellidæ), which are eaten to a small extent. The great bulk of the beetle food consists of small leaf-beetles (Chrysomelidæ), with some weevils, and several others. One stomach contained the remains of 52 specimens of *Notoxus alamedæ*, a small beetle living on trees. Bugs (Hemiptera) constitute over 19 percent of the food, and are eaten regularly every month. Most of them consist of leaf-hoppers (Jassidæ) and other active forms, but the black olive scale appeared in a number of stomachs. Plant-lice were not positively identified, but some stomachs contained a pasty mass, which was probably made up of these insects in an advanced stage of digestion.

Flies seem to be acceptable to the summer warbler: they are eaten to the extent of nearly 9 percent. Some of them are of the family of the house fly, others are long-legged tipulids, but the greater number were the smaller species commonly known as gnats. A few small soft-bodied Orthoptera (tree-crickets), a dragon-fly, and a few remains not identified, in all about 5 percent, made up the rest of the animal food.

Vegetable food.—The vegetable portion is only about 2½ percent. Nearly all of this was fruit pulp contained in a single stomach. This, with one or two seeds and a few accidental bits of rubbish, makes up the whole vegetable contingent, which, therefore, may be dismissed without further comment.

FOOD OF NESTLINGS.

Some idea of the amount of insect food eaten by warblers may be obtained by watching the feeding of their young by the parent birds. A nest of the summer warbler containing two young, about a week old when discovered, was watched for six hours distributed over three days. The nest was situated in a prune tree in an orchard, and it is practically certain that all the food for this family was obtained in the orchard. The results of the observation appear in the following table:

Date.	Forenoon.		Afternoon.	
	Hour of observation.	Number of feedings.	Hour of observation.	Number of feedings.
June 12	.....	.....	3.26–4.26	21
June 14	8.21– 9.21	31	.....	.....
June 14	10.34–11.34	32	4.36–5.36	31
June 15	8.00– 9.00	36	1.11–2.11	30

In six hours 181 feedings were observed, an average of 30⅙ per hour. As there were only two young, it follows that each nestling was fed 15 times per hour, or for a day of fourteen hours 210 times. Both parent birds took part in feeding the young, but it was noted that the female visited the nest most frequently.

SUMMARY.

From the above facts it is evident that the presence of a few warbler nests in an orchard goes far to safeguard the trees from attacks of insect enemies. The inference is plain that the presence of insectivorous birds should be encouraged by the orchardist by every means in his power. The summer warbler is, if possible, even more completely beneficial in its food habits than the Audubon warbler. Its animal food in relation to man is almost entirely noxious or neutral, and it eats so little vegetable food that its character is of but slight consequence.

WESTERN YELLOWTHROAT.

(*Geothlypis trichas* subspp.)

In California the yellowthroat is an inhabitant of marshes and low, bushy places among tules or willows. While it is an insect eater of

the highest order, it does not so directly affect the interests of horticulture as it would if it frequented orchards and gardens. It may be said, however, that as the swamps and thickets in which it lives are the recruiting grounds for many orchard pests, the bird that destroys them in their native haunts is by no means without economic value.

In a somewhat restricted investigation of the food of this bird 114 stomachs, taken in every month except January, were examined.

Vegetable food.—A few seeds and bits of rubbish is the sum total of the vegetable food, and it is probable that these were taken accidentally. Some of the ants of California store up seeds, and when snapping up ants the yellowthroat probably takes the seeds along with them.

Animal matter.—The animal matter amounted to 99.8 percent of the total food. The largest item is Hymenoptera, amounting to 35 percent, of which about half is ants and the remainder wild bees, wasps, etc.

Hemiptera amount to 28 percent, and are made up of leaf-bugs, leaf-hoppers, tree-hoppers, plant-lice, scales, and probably some others not identifiable. The black olive scale was found in a few stomachs and plant-lice in one, but the other families were a pretty constant component of the food in every month.

Beetles were eaten to the extent of nearly 15 percent, and are mostly harmful species, the exception being a few coccinellids of the genus Scymnus, which, however, do not amount to 1 percent of the whole. Weevils and others of the more common families make up the rest of this portion of the diet. The three orders of insects mentioned above form the great bulk of the food of the yellowthroat, and are regularly eaten throughout the year.

Caterpillars and moths comprise 5 percent, but, so far as the stomachs at hand show, are eaten very irregularly and do not appear on the preferred list. The same may be said of Diptera, though they amount to 12 percent, but in several months none were eaten. Grasshoppers were found in only four stomachs, but one of these contained nothing else. Spiders are taken to the extent of nearly 4 percent, but in some months none were found and only a trace in others.

SUMMARY.

From the above rather brief survey of the food of the yellowthroat it is evident that the horticulturist has nothing to fear from this bird should it change its habitat and become an inhabitant of orchards and vineyards. It is practically wholly insectivorous, and the insects it eats are either harmful or of little economic value. It eats no fruit or grain, nor, so far as known, any other useful product. Like other members of the family, its life is passed in unceasing search for insects.

ORANGE-CROWNED WARBLER.

(*Helminthophila celata* subspp.)

The genus Helminthophila is next to Dendroica in the number of species and subspecies it contains, but still falls far below it. Several species occur in California, but the one under consideration is probably the most important. Only 65 stomachs were available for examination, but they confirm the evidence already obtained from other species.

Vegetable food.—Less than 9 percent of the food is vegetable matter, and is made up of 3 percent of fruit and rather more than 5 percent of various substances, such as leaf galls, seeds, and rubbish. Fruit was found in only a few stomachs, but the percentage in each was considerable; figs were the only variety identified.

Animal food.—The animal matter in these stomachs amounts to 91 percent of the food. Hemiptera are the largest item and amount to over 25 percent, mostly leaf-bugs, leaf-hoppers, plant-lice, and scales. Plant-lice were found in only one stomach and scales in 5, of which 3 contained the black olive species. Beetles amount to about 19 percent of the food, and with the exception of a few Coccinellidæ are of harmful families, among which are a number of weevils.

Beetles and bugs are the two orders of insects that are not only eaten to the greatest extent but are taken with great regularity, and form a respectable percentage of the food in every month.

Caterpillars are eaten rather irregularly, though they aggregate 24 percent for the year. Stomachs collected in several months contained none, while in others they amounted to more than half the food. Probably the examination of a greater number of stomachs would show more regularity in the consumption of these insects.

Hymenoptera amount nearly to 15 percent, and are mostly small wasps, though some ants are eaten. This is the smallest percentage for this order that has yet been found in the food of any warbler.

Flies are represented by less than 1 percent, which is unusually small. Perhaps this warbler lacks the skill to catch such agile insects. Seven percent of spiders were found in the stomachs, the largest percentage of these creatures for any warbler. This again indicates that the orange-crown is most successful in hunting sluggish game, such as beetles, bugs, and spiders.

GOLDEN PILEOLATED WARBLER.

(*Wilsonia pusilla* subspp.)

The golden pileolated warbler is another of the small birds that summer here and there on the Pacific coast, mostly in willows and

other shrubbery, but not rarely in the orchard. During the migration it is common and widespread.

Fifty-two stomachs of this bird have been examined, and though the evidence is somewhat fragmentary, it suffices to reveal the general character of the food.

Animal food.—Animal matter amounts to over 93 percent, vegetable to less than 7 percent. Of the former, the larger item is Hemiptera, which aggregates over 35 percent. The black olive scale was found in four stomachs, but leaf-hoppers make up the bulk of this portion of the food. Hymenoptera stand next in importance, with 31 percent, made up of both wasps and ants.

Flies are eaten to the extent of 11 percent, and in connection with the Hymenoptera proves what observation of its habits indicate, that this bird gets much of its food when on the wing. A good many of the insects were the tipulids, or crane-flies.

Beetles of half a dozen different families were eaten to the extent of about 9 percent. They were mostly leaf-beetles (Chrysomelidæ), with a few weevils and one or two others. No coccinellids were found.

Somewhat less than 5 percent of the food consists of caterpillars. They do not appear to be favorite food, for they are eaten very irregularly. Spiders also are taken only sparingly, and form but little more than 1 percent of the total food.

Vegetable food.—The vegetable food, less than 7 percent of the total, is made up almost entirely of fruit pulp, and was eaten in the months of September and October.

SUMMARY.

The foregoing hasty review of the food of the golden pileolated warbler shows that its food habits are practically the same as those of other members of the family. The food is largely composed of insects, and its two most prominent elements are Hymenoptera and Hemiptera, which are eaten extensively and very regularly through the year. The other components of the diet apparently are taken with less regularity.

WESTERN MOCKING BIRD.

(*Mimus polyglottos leucopterus.*)

The mocking bird has always been held in such high esteem as a singer that perhaps it would be useless to attempt to add to the bird's repute by showing that its food habits are of a high order of economic interest. Moreover, the title of the mocking bird to be ranked as an economic benefactor is not quite clear, for, though it

does considerable good by the destruction of harmful insects, it eats much fruit, and from the Southern States, particularly Texas and Florida, where fruit raising is an important industry, have come bitter complaints against it. In Florida the bird is said to attack grapes and oranges, and in Texas it is asserted that figs are to be added to its food list.

In California the mocking bird is a common resident only in the southern half of the State and is very common only in restricted portions. No serious complaints of the bird's depredations in this State have yet been made, but this perhaps is due to the fact that mocking birds are rare in sections where cherries and the smaller deciduous fruits are grown. Where mockers are most abundant, citrus fruits are the principal crop and the birds do not appear to molest them.

While a number of stomachs of this bird have been examined, they are too few and too unequally distributed over the region under investigation to justify final conclusions with regard to the animal food; still they furnish information of value. It so happens that 33 stomachs were taken between July 18 and August 18, and another a few days later. All but one of these stomachs were from the region about Los Angeles, and this one was collected at Fresno. The average, therefore, is a little more than one stomach a day for this period, and gives a fair idea of the food for the time and locality.

The first analysis gives 23 percent of animal matter and 77 percent of vegetable. There was no stomach which did not contain some vegetable food, while 10 had no animal matter.

Animal food.—Beetles of several families formed a little less than 1 percent. Hymenoptera, largely ants, were eaten to the extent of somewhat more than 10 percent. Grasshoppers constituted the largest item of animal food, and amounted to 11 percent of the whole. A few caterpillars and spiders made up the other 1 percent of the animal food.

Vegetable food.—Of the 77 percent of vegetable food nearly 74 percent was diagnosed as fruit. Some of this, of course, was wild, but blackberries or raspberries, grapes, and figs were found in many stomachs. Many of the birds were taken in orchards and gardens, and some were shot in the very act of pilfering blackberries. Others were taken in a wild arroyo away from cultivation. The only species of wild fruits that were identified were elderberries, which were found in a few stomachs. The other vegetable matter was made up of several elements. Of these, the seeds of poison oak (Pl. II, fig. 9) are perhaps the most conspicuous, and one stomach was entirely filled with them. A few weed seeds and some rubbish completed the vegetable part of the food.

Besides the 34 stomachs already discussed, 19 others were examined, but as they represent nine months of the year they are too few to afford a criterion of the usual food for those months; but they give a hint at least of what is eaten at other times than midsummer. Two stomachs were taken in March, one of which was filled with animal food, and the other also, except 1 percent of vegetable rubbish. The animal portion consisted of harmful insects, except one lizard. This seems peculiar food for a mocking bird, and is to be considered beneficial. The one stomach taken in May was filled with seeds of poison oak. A stomach collected in June contained 8 percent of caterpillars; small fruit, probably wild, constituted the rest of the contents. Six stomachs taken in August contained 22 percent of animal matter to 78 of vegetable. The animal food consisted of beetles, ants, and grasshoppers. The vegetable portion was made up of some wild grapelike fruit and a little fig pulp with some elderberries. Of four stomachs taken in September, one was filled with insects and spiders. The three others contained a few wasps, with fruit and other vegetable matter. The only insect to be considered useful was one carabid beetle. Of the three stomachs collected in October, one was filled with the seeds and pulp of grapes and figs; one contained 27 percent of grasshoppers and 73 percent of some wild berry not positively identified, while the third contained a few grasshopper remains and 92 percent of wild seed. The stomach collected in December was filled with seeds and pulp of figs and grapes. One stomach was taken in January which contained 70 percent of harmful insects and 30 percent of seeds of poison oak.

FOOD OF YOUNG.

Among these stomachs was one of a nestling about a week old. It contained 92 percent of grasshoppers and crickets and 8 percent of some wild fruit. So far as it goes, this indicates that mockers follow the general rule and feed their young largely on animal food of the softer kind—that is, grasshoppers instead of beetles.

SUMMARY.

Reviewing the contents of the 52 stomachs we find 29 percent of animal matter and 71 of vegetable. Of the animal food the largest item is Hymenoptera, 10 percent, and then in order, Orthoptera 7 percent, Coleoptera 6 percent, Lepidoptera 5 percent, miscellaneous 1 percent. The vegetable food consists of 50 percent of fruit and 21 percent of seeds and other items. These results prove that the mocking bird eats insects to a considerable extent, but they are not con-

clusive as to the elements of its preferred diet. It is evident that it is fond of fruit, and where abundant the bird may become a menace to the orchard and vineyard.

CALIFORNIA THRASHER.

(*Toxostoma redivivum.*)

Thrashers are eminently birds of the underbrush. While they occasionally alight on trees at some height from the ground, they are more frequently seen under bushes or skulking out of sight in some almost impenetrable thicket of briars. When, however, the thrasher wakes in the morning and feels his soul overflowing with song, he perches on the topmost twig of a tree and lets the world know that he is there and believes that life is worth living.

The food of the thrasher is obtained on or near the ground. The long curved bill of the California species is probably used much as many birds use their claws to dig among dead leaves and other rubbish for insects. The bird is not fastidious in its diet, and examination of the stomachs reveals a good many bits of dead leaves, rotten wood, plant stems, which are carelessly taken along with more nutritious morsels.

An examination of 82 stomachs of this species shows that vegetable food exceeds the animal in the proportion of 59 to 41. In the eastern species (*T. rufum*) the ratio is 36 to 64. This result is rather surprising, for, as a general rule, California birds eat a larger proportion of animal food than do the most nearly related eastern species.

Animal food.—As the thrasher is eminently a ground forager it would naturally be expected to find and eat many ground-living beetles. Of these the Carabidæ are the most important, owing to their predaceous habits; so a separate account of this family was kept. The result shows that they enter the food of the thrasher to the extent only of 3.8 percent, while all other beetles amount to nearly 6 percent. Of these, the darkling beetles (Tenebrionidæ) are the most numerous, and the May beetles (Scarabæidæ) next. But very few weevils or other species that live on trees or foliage were found. Of all the insects, Hymenoptera are the most abundant, as they are also the most constant element of the thrasher's food. About half of these are ants, the rest wasps and bees. Ants naturally are the insects most often found by this bird, as many species live on the ground and among rubbish and rotten wood. The occurrence in the food of wasps and bees, on the contrary, is somewhat of a surprise, as they are mostly sun-loving insects more often found on flowers or the leaves of trees than under bushes or thickets where the thrasher delights to forage. Together they make up something more than 12 percent of the food

of the year. Two specimens of worker honey-bees (*Apis mellifera*) were found in one stomach. None of the other Hymenoptera was of specially useful species.

Caterpillars, cocoons, and moths amount to a little more than 8 percent of the food, and the greater number were eaten during the winter months. It is probable that they were hibernating and were raked out from under dead leaves or other rubbish. A few bugs, flies, grasshoppers, and spiders make up the rest of the animal food—about 6 percent. Spiders and myriapods amount to a little more than 6 percent.

Vegetable food.—The vegetable food may be divided into three parts: Fruit, poison-oak seeds, and miscellaneous vegetable matter. Fruit represents nearly 18 percent, but it probably is not of much value. Several stomachs contained pulp that could not be identified with certainty, and might have been that of some cultivated variety. Seeds of Rubus fruits (blackberries or raspberries) were found in 12 stomachs out of the 82. These, however, are as likely to have been wild as cultivated. Elderberry seeds were discovered in 10 stomachs, Cascara, or coffee berries (*Rhamnus californicus*), in 5, and manzanita berries in 1. The seed of poison oak (*Rhus diversiloba*, Pl. II, fig. 9), and a few of the nonpoisonous species of Rhus were eaten to the extent of 14 percent of the food. They were not found in many stomachs, but appear to be eaten in considerable quantities when eaten at all. The thrasher must be added to the list of birds that assist in the dissemination of the seeds of this noxious plant.

The miscellaneous part of the vegetable food amounts to over 26 percent, and is made up of mast, weed seed, galls, and rubbish. The mast was not further identifiable. Most of the seeds were so broken and ground up that only a few species were identified. Two stomachs contained remains of grain—wheat in one and corn in the other. Leaf galls were found in several stomachs, and rubbish in quite a number, though here again it is difficult to draw the line between food proper and stuff that is accidentally picked up with it.

SUMMARY.

Although the thrashers eat some fruit, most of it is wild and of no value. Moreover, the bird's habits are such as to preclude the likelihood that it will ever become a resident of orchards. Grain evidently is not a favorite food, and if it were it is doubtful if the bird would leave its chosen haunts for the sake of procuring it. It is not probable that the California thrasher will ever become of special economic interest unless under very exceptional circumstances. In the meantime it performs its part in the great work of reducing the vast numbers of insects.

WRENS.

Since the time to which history runneth not the wren family, represented by one or other of its members, has attached itself to the abodes of man. Wherever man settles some member of this group is ready to greet him, to take advantage of his improvements, and to aid in the fight against his insect enemies. The common wren of Europe and the house wren of eastern North America habitually choose crannies in buildings or fences for nesting places, or if hollow trees are selected they usually are near human dwellings, preferably fruit trees in orchards or gardens. When civilization was pushed to the Pacific coast, wrens were there ready to welcome the new order of things. In food habits the wrens proper (Troglodytinæ) are largely insectivorous. While occasionally they eat a seed or a bit of fruit, the quantity taken by most species during the year is so small in comparison to the animal portion as to be insignificant. The insects eaten by the wrens are mostly noxious species, such as infest the foliage and branches of trees and shrubs, and the domestic habits of the wrens enable them to attack these pests in the very places where they are most harmful—that is, in the garden and orchard. The predaceous beetles (Carabidæ), which live mostly on the ground, are protected from the wrens by this very habit, as the latter seldom forages in such places. Moreover, the species most valuable to man are rather large prey for such small birds.

BEWICK WREN.

(*Thryomanes bewicki* subspp.)

The Bewick wren is one of the species which to a considerable extent occupies in California the place of the house wren in the Eastern States. The nesting habits of the two are practically identical, and the economic value of the former is just as great as that of the latter.

Investigation of this bird's food is based upon the examination of 146 stomachs taken in every month of the year. Of its diet for the year a little more than 97 percent consists of insects and less than 3 percent of vegetable matter.

Vegetable food.—The largest quantity of vegetable matter was eaten in December and January and formed about 12 percent of the food in each of these months. In three months—March, June, and September—no vegetable food was found in the stomachs. It is hardly probable, however, that such would always be the case in these months. What was supposed to be pulp of fruit was found in one stomach. This was the only vegetable substance noted that could possibly be useful to man. Six stomachs contained seeds more or less broken, of which only one was identified, a single seed of turkey

mullen (*Eremocarpus setigerus*). In one stomach was a small gall, and in six were various substances, such as bits of dead leaves, plant stems, and rotten wood, which may properly be denominated rubbish.

Animal food.—Of the animal food various families of bugs (Hemiptera) make up the largest percentage. One of the most interesting items is the black olive scale, which was found in a number of stomachs but does not appear to be eaten extensively. The great bulk of the hemipterous food was made up of leaf-bugs, stink-bugs, shield-bugs, leaf-hoppers, tree-hoppers, and jumping plant-lice, though there were representatives of other families. The aggregate of the Hemiptera eaten is about 31 percent of the total food. It is distributed with great regularity through the year and varies less from month to month than any other food. With the exception of the olive scale no specially harmful species was identified, but bugs belonging to the same family as the notorious chinch bug were found. As a vast majority of the members of this order are injurious to vegetation their destruction by birds must be considered beneficial.

Beetles collectively amount to over 21 percent of the food. They may be placed in three groups—ladybirds, weevils, and other beetles. Ladybirds are probably the most useful insects of the whole order of Coleoptera, so that their destruction by birds is to be deplored. Bewick's wren eats them to the extent of a little more than 3 percent of the whole food. This is not a large percentage, though greater than could be wished. On the other hand, the bird eats weevils, or snout-beetles, to the extent of nearly 10 percent of its food. As all the members of this group (Rhynchophora) are practically harmful, and some of them the worst pests of the orchard and forest, it must be allowed that we are paid for our ladybirds at a fairly good price. A number of stomachs contained beetles of this group belonging to the family of engravers (Scolytidæ), which live under the bark of trees and greatly damage the timber. The stomachs of two wrens taken in Pacific Grove in the month of January contained 85 and 80 percent of these beetles.

The owners of the Pacific Grove pine forests have engaged the services of an expert to investigate the damage being done to the pines by scolytids and other insects, and, if possible, to devise a remedy. Is it not evident that the bird under consideration is one of Nature's remedies for this evil? The trouble is that there are not enough birds to wage effective war against the insects. In many cases, perhaps in this one, man himself is partly to blame for present conditions. The birds are destroyed—destruction of the forest follows. By furnishing proper facilities for breeding in the shape of bird boxes the numbers of this wren in the State of California may be greatly increased and the forest trees correspondingly protected from insects.

Other beetles, mostly leaf-beetles (Chrysomelidæ) were eaten to the extent of a little more than 8 percent. While nearly all of the leaf-beetles are theoretically harmful none of those identified in the food are especially destructive to crops.

Hymenoptera, including both ants and wasps, aggregate a little more than 17 percent of the wren's diet. They are a fairly constant constituent of the food and do not appear to vary much according to season. The greater number was found in March, but as only two stomachs were collected in this month the record is not conclusive. Ants form about 7 percent of the food. The economic relations of these insects have been discussed elsewhere. Wasps make up the rest of the item, about 10 percent, and have no especial economic significance. Caterpillars and a few moths and some cocoons constitute a little less than 12 percent of the wren's food. Contrary to what might be expected, not all these are taken in summer. The 14 stomachs obtained in February contained caterpillars to the amount of over 13 percent of their contents. They were probably found hibernating in crevices of bark. A few moths were eaten, but, as usual, they were only a small item of the food. Small cocoons of tineid moths were found in a number of stomachs.

Grasshoppers amount to 4 percent of the wren's diet. Most of them are eaten during the summer and fall, though some appeared in stomachs taken in January. While these insects are a favorite food for many birds they are probably rather large and too terrestrial in habits to be eaten in great numbers by wrens. Other insects, mostly flies and a few remains which could not be identified, make up about 6 percent of the stomachs' contents. Flies (Diptera) are eaten very irregularly and appear not to be relished. Spiders are taken to the extent of somewhat more than 5 percent of the total food. As spiders live about trees, bushes, fences, rocks, and outbuildings it is not surprising that they are captured by wrens, but the rule seems to be that while all insectivorous birds eat spiders to some extent no species eats many.

List of insects found in stomachs of Bewick wren:

COLEOPTERA.

Cercyon fulvipenne.
Hippodamia convergens.
Cocinella t. californica.
Scymnus marginicollis.
Aphodius rugifrons.
Microrhopala montana.
Diachus auratus.
Crepidodera helxines.
Epitrix parvula.
Exema conspersa.
Diabrotica soror.
Cryptocephalus castaneus.
Gastroidea sp.
Bruchus seminulum.
Blapstinus dilatatus.
Notoxus alameda.
Centorhynchus nodipennis.
Pelenomus carifrons.
Apion sp.

HEMIPTERA.

Sinea diadema. *Saissetia oleæ.*

Remains of insects belonging to the following families were found, but not further identified:

COLEOPTERA.

Carabidæ.
Hydrophilidæ.
Staphylinidæ.
Coccinellidæ.
Elateridæ.
Scarabæidæ.
Chrysomelidæ.
Bruchidæ.
Tenebrionidæ.
Anthicidæ.
Curculionidæ.
Scolytidæ.
Other Rhynchophora.

DIPTERA.

Muscidæ.
Tipulidæ.

HEMIPTERA.

Emesidæ.
Reduviidæ.
Aradidæ.
Capsidæ.
Lygæidæ.
Pentatomidæ.
Corimelænidæ.
Scutelleridæ.
Jassidæ.
Membracidæ.
Psyllidæ.
Coccidæ.

WESTERN HOUSE WREN.

(*Troglodytes ædon* subspp.)

The western house wren, like its eastern relative, is a common resident about outbuildings and other structures that offer suitable nesting sites and good foraging ground. In its general appearance and habits it is so like the Bewick wren that the casual observer is likely to confuse the two. Like other members of the family, it is largely insectivorous and rarely eats vegetable food.

Only 36 stomachs of this species from California are available for examination, but the character of the food agrees so nearly with that of the eastern form that the general results obtained from the study of that subspecies may be applied to the western bird.

Animal food.—In the 36 stomachs examined animal matter, consisting entirely of insects and spiders, formed 97.5 percent, and vegetable food 2.5 percent. Beetles, as a whole, amount to about 20 percent; caterpillars, aggregating 24 percent, are taken in the earlier months of the year; and Hemiptera, amounting to 33 percent, are eaten chiefly in the last of the season. Grasshoppers amount to about 5 percent, and different insects, mostly ants and other Hymenoptera, aggregate 15 per cent.

Vegetable food.—The vegetable matter consists of rubbish and one grass seed, probably all of it swallowed accidentally.

Among the 36 stomachs, of which the record has just been given, were 18 nestlings, some being about a week old, others about ready to leave the nest. The results of the examination of these were tabulated by themselves in order to determine the differences, if any, between the food of the adults and that of the young. No vegetable matter was found in any of the stomachs, and the animal food was distributed among a comparatively few elements. Bugs (Hemiptera) are the largest item, and amount to nearly 36 percent. Caterpillars and grasshoppers stand next, with 17 and 16 percent, respectively.

It is interesting to note that about three times as many grasshoppers are fed to the young as are eaten by the adults. Wasps and ants amount to a little more than 6 percent, and are the smallest item. Spiders appear to the extent of a little over 11 percent. Beetles, however, constitute the most interesting item of the food. They were eaten to an average extent of somewhat more than 11 percent, and were nearly all ladybirds (Coccinellidæ) contained in the stomachs of five individuals of a brood of six. The amount in each stomach varied from 15 to 65 percent of the contents, and averaged 29 percent of each of the six birds. It is a question which is the more surprising, that this brood had eaten so many coccinellids, or that the others had eaten so few. Only three other stomachs contained any of these beetles and those were all adults. The house wren does not exhibit any special proclivities for ladybirds, and it would seem probable that in this case either other food was wanting or these beetles were specially abundant.

In addition to the examination of stomachs, observations were made upon the feeding of nestling wrens. A nest situated in the porch of the house of Mr. W. O. Emerson, at Haywards, Cal., was observed for one-hour periods from soon after the young were hatched until they were nearly ready to fly. The nest was watched at various times of day, so as to include as nearly as possible all hours of daylight. During the first two periods the male aided in feeding the young, but afterwards was not seen, and the whole care of the young devolved upon the mother. The number of young probably was not fewer than six. Following are the results in tabular form:

Date.	Forenoon.		Afternoon.	
	Hour of observation.	Number of feedings.	Hour of observation.	Number of feedings.
May 18...	10.00–11.00	8	4.00–5.00	7
May 19...	9.35–10.35	13	4.30–5.30	10
May 20...	10.29–11.29	16	.....	.....
May 21...	8.23– 9.23	20	2.01–3.01	12
May 23...	8.22– 9.22	19	.....	.....
May 26...	10.35–11.35	32	.....	.....
May 27...	.....	.....	2.36–3.36	31
May 28...	8.20– 9.20	38	.....	.....
May 30...	10.40–11.40	28	.....	.....

As will be noticed, the whole time of observation covered a period of thirteen days, although the nest was not watched every day. In all the nest was watched for twelve hours, and the total number of times that food was brought to the young was 234, or an average of 19½ times per hour. The young were fed as early as 5 o'clock in the morning and as late as 7 in the evening, thus making for the parent birds a working day of fourteen hours. Only a little plain arithmetic is necessary to show very nearly the number of insects destroyed by this family in a single day.

These observations were made with watch in hand and the time of each feeding noted. In many cases the parent bird was away in search of food only half a minute. Once there was a heavy mist nearly all day, when the mother wren was hard pressed to find food for the ever-gaping mouths of her young. No flying insects were abroad, and the supply of caterpillars from the immediate vicinity had been exhausted. In this extremity the mother turned her attention to spiders and was seen to visit the interior of a summer house, also to investigate a pile of flower pots and tubs and to plunge into and under an evergreen hedge in search of something that would answer for food. As the nest was watched at very short range, it was often possible to determine the nature of the food brought by the parent. When the nestlings were very young, it consisted almost entirely of small green caterpillars, commonly called 'canker-worms.' Later this was varied by tipulid flies (daddy-long-legs), small moths, and spiders. Some of the insects brought were not determinable, probably flies and wasps.

SUMMARY.

From the above sketch of the food of the house wren it will be seen that there is practically only one item to which exception can be taken, namely, the coccinellid beetles, or ladybugs. But the record is so meager that it is not safe to draw general conclusions. It is probable that a more extensive investigation of the food of the California bird will show that it is entitled to the same high economic rank as its eastern relative.

WESTERN MARSH WREN.

(*Telmatodytes palustris* subspp.)

The marsh wren, as its name indicates, is a resident of swamps and marshy grounds. At first thought its food might not appear to be of any economic importance, but investigation shows that it does not differ from that of the orchard wrens as much as one might infer from difference of habitat. Only 53 stomachs of this species have been obtained for examination. While this number is not sufficient as a basis for final judgment, it suffices to show how closely the food of this species resembles that of its congeners.

Vegetable food.—But little vegetable food was found in the stomach of the marsh wren, and the precise value of most of that was not determinable. A few seeds of sedge and one of amaranth were all that were identified. The total amount was a trifle over 2 percent.

Animal food.—Beetles, wasps, ants, bugs, caterpillars, and a few miscellaneous insects, with some spiders and snails, make up the bill of fare. As with the Bewick and the house wren, bugs are the largest item, but do not quite equal the quantity eaten by those industrious bug-hunters. While the Bewick eats these insects to the extent of 31 percent of its food, the marsh wren eats them only to the amount of 29 percent. In this respect there seems to be little difference between the bird that gets its food from trees and the one that feeds among the tules and sedges. The families represented are those of the assassin-bugs, damsel-bugs, leaf-bugs, stink-bugs, leaf-hoppers, and tree-hoppers, most of which are usually found on trees—in fact, one is forced to the conclusion that the marsh wren must at times forage upon trees or shrubs. Scales were found in one stomach, which is another point of resemblance between the diet of this bird and that of the habitual tree inhabiters.

In the marsh wren's food caterpillars and chrysalids rank next to bugs in importance. They amount to about 17 percent of the whole, and appear in the food of every month. Cocoons of tineid moths were contained in a number of stomachs, another indication that the birds visit trees.

Beetles constitute 16 percent of the food. While a number of the commoner families are represented, the terrestrial forms are rather more prominent than in the food of the arboreal wrens. A few carabids and a number of coccinellids together make up 2 percent of the food, and were the only useful insects eaten, unless the assassin-bugs are reckoned as such. As these feed on other insects they must of course do some good. Ants and wasps amount to about 8 percent of the food, and most of them were eaten during the fall months. Flies, grasshoppers, dragon-flies, and a few insect remains not further identified make up over 11 percent of the food. They were eaten very irregularly. Spiders constitute somewhat more than 5 percent, and, as usual, are very regularly eaten, but in small numbers. Small mollusks (snails) were eaten by quite a number of birds, and 1 stomach contained 11 specimens.

SUMMARY.

This brief review of the food of the marsh wren, while not absolutely conclusive, is sufficiently near the truth to prove that the bird is to be ranked among our eminently useful species. Of some birds it has been said that their peculiar merit lies in the fact that they reside in orchards and cultivated ground and hence destroy insect

pests in the very places where their mischief is done. This can not be asserted of the marsh wren, but it must be remembered that many harmful species of insects breed and live in marshes and waste places as well as in grainfields and orchards, so that the birds which destroy them on wild lands are removing the source of supply from which are recruited the hosts that infest the farm.

CACTUS WREN.

(*Heleodytes brunneicapillus.*)

(Pl. IV.)

The cactus wren is so exclusively a bird of the desert and waste places that its food may be thought to have little, if any, economic interest. It is not safe to assume, however, that the bird will never affect the interests of agriculture because it does not do so at present. Moreover, its food habits have a scientific interest which justifies a brief review. A number of the birds whose stomachs have been examined for this work were taken near orchards and grainfields, and there can be little doubt that, with the spread of cultivation, the species will adapt itself to a somewhat different environment and become of economic importance. We find, in fact, that its food is made up of practically the same orders and families of insects that compose the diet of birds living on agricultural lands, but the relative proportions differ widely, and in most cases the species are probably different.

Only 41 stomachs of the cactus wren were available for examination. They were taken in the region from Los Angeles to San Bernardino, and from July to January, inclusive. They contained about 83 percent of animal matter to 17 of vegetable.

Animal food.—Beetles and Hymenoptera, the latter ants and wasps, were the two most important items of the animal food. Each made up about 27 percent of the total. The beetles belong to several families, but weevils, or snout-beetles, were the most noticeable, and amount to somewhat more than 10 percent. One stomach contained 11 of these insects and another 10, while others held fewer. Only one species, *Rhigopsis effracta*, was identified. Five of these were in 1 stomach. The other beetles belong to more common families. Coccinellids were found in 1 stomach and carrion beetles in 2. They were the only insects noted that can be considered as useful. Hymenoptera are represented by many ants and a few wasps. These are just the insects which the cactus wren might be expected to find, for dry land and sunshine are the conditions which favor these creatures. Grasshoppers amount to a little more than 15 percent. This

CACTUS WREN (HELEODYTES BRUNNEICAPILLUS COUESI).

is the only wren that eats these insects to any considerable extent except as nestlings.

Bugs (Hemiptera) amount to only a little more than 5 percent of the food, which is the smallest quantity eaten by any of the wren family. This item, however, contains one unexpected element—that is, black scales (Saissetia). These appeared in 6 stomachs, and must have been obtained from trees or shrubs, possibly from fruit trees. In any case their destruction is a welcome service. Caterpillars and their allies (Lepidoptera) were eaten to the extent of a little more than 5 percent. Among them were many cocoons of tineid moths, indicating again that the cactus wren obtains some of its food from trees and shrubs. A few unidentifiable insects and spiders amount to somewhat more than 3 percent. This is the smallest record for spiders of any of the wren family, which is much given to eating these creatures, finding them in crannies in rocks, stumps, and other places. A few of the long bones of a tree frog were found in 1 stomach.

Vegetable food.—Seventeen percent of vegetable matter was found in the stomachs of this bird. This is the largest percentage found in the stomachs of any species of wren yet examined. The vegetable food of the cactus wren consists of fruit pulp and weed seeds. The former amounts to nearly 13 percent, but in all cases where identification was possible consisted of wild species. Of these, only 3 were fully identified—cactus (Opuntia), elderberry (Sambucus), and Cascara (Rhamnus), the last only in 1 stomach. Nothing was found to indicate that cultivated varieties had been eaten. Seeds, which amount to 4 percent, are those of the poison oak (Rhus), and a nonpoisonous species, with filaree (Erodium) and Amisinckia, most of them useless plants or worse.

SUMMARY.

From this brief inspection of the cactus wren's food it is seen that it contains but little that is useful to man, while the great bulk is made up of elements that are, or would be, harmful if present on cultivated lands. The bird thus sustains the good reputation of the rest of its family.

OTHER WRENS.

Some half a dozen stomachs each of the western winter wren (*Olbiorchilus hiemalis pacificus*) and dotted canyon wren (*Catherpes mexicanus punctulatus*) and the rock wren (*Salpinctes obsoletus*) have been examined. This number is entirely too small to serve for specific statements in regard to their food except that it may be said

that it corresponds closely to that of the other species of the family discussed in foregoing pages.

From this somewhat limited investigation of the food of the California wrens several points may be regarded as established: (1) That these wrens are essentially insectivorous; (2) that an overwhelming majority of the insects composing their food are harmful species; (3) that the quantity of vegetable food eaten is so small as to have no economic importance.

CALIFORNIA CREEPER.

(*Certhia familiaris occidentalis.*)

Only 7 stomachs of the California creeper were available for examination, but they confirm the good opinion observers have formed of the habits of this bird. Like the titmice and nuthatches, the creeper is an indefatigable forager on the trunks and branches of trees, and the food it obtains there is of the same nature—that is, small beetles (many of them weevils), wasps, ants, bugs, caterpillars, and a few spiders. Of the 7 stomachs examined, only 1 contained vegetable food, and this had only 19 percent of seed, too much digested for identification.

While the creeper is not systematically classed with the nuthatches and titmice, its food habits closely ally it to these birds and to the wrens, and whatever good is true of them applies with equal force to the creeper.

NUTHATCHES AND TITMICE.

(Paridæ.)

Few families of birds contain so many absolutely harmless and thoroughly useful species as that of the nuthatches and titmice. All of the American species are small, and several are so minute that the larger species of humming birds exceed them in size. In colors they are neither brilliant nor showy, black, white, brown, and gray being the predominant tints of their plumage. In manners and voice they are equally unobtrusive, and so little do their movements attract attention that one may be surrounded by them in the forest before he is conscious of their presence. More than forty species and subspecies of the titmouse family reside within the limits of the United States, of which some fifteen live in California.

From an economic standpoint the titmice are the reverse of insignificant. They are essentially inhabitants of trees and shrubs, and obtain almost their entire living from them. Their food consists largely of small insects and their eggs and larvæ, and, as the individuals of most of the species are numerous and spend all the daylight hours searching for food, it follows that the number of harmful

creatures they destroy is beyond calculation. As conservators of forest and orchards there are few birds that compare with them. The insects they destroy are largely those that feed upon the leaves, blossoms, and fruit of trees, with some that bore into the wood or burrow under the bark, thereby injuring or killing the tree itself. On the other hand, they do not prey upon fruit, grain, or other product of husbandry. The small amount of vegetable matter they eat consists principally of small galls, whose destruction is a benefit, with a few seeds and a little wild fruit.

PYGMY NUTHATCH.

(*Sitta pygmæa.*)

The nuthatches are small, inconspicuous birds that live upon trees and for the most part remain in forests or groves, though not rarely visiting the orchard. While allied to titmice they form a fairly well-defined group and can be easily distinguished from titmice proper. As gymnasts they probably lead the avian world. After watching their movements one might suppose that nature had quite exempted them from the operation of the laws of gravity, as they move up or down a tree with equal facility, or along the underside of a horizontal branch where they inspect a promising knot hole or cranny, apparently without the least idea that they are upside down. The food they obtain from trees is of the same general character as that of the rest of the titmouse family.

Unfortunately only a few stomachs of these birds are at hand for examination—enough, however, to give a general idea of the diet.

The pygmy nuthatch is the smallest of the group, but as a destroyer of noxious insects it is far from insignificant. Only 31 stomachs of this feathered midget are available for examination, but the number is sufficient to bring out some strong points of the bird's diet. The relative proportions of animal and vegetable food, as indicated by the contents of these stomachs, are approximately 83 percent of the former to 17 percent of the latter.

Animal food.—The largest item of animal food is Hymenoptera, composed mostly of wasps, with a few ants. They amount to about 38 percent of the whole. Next in order are Hemiptera, aggregating 23 percent. A large proportion of these belong to the family Cercopidæ, commonly known as spittle-insects, from the fact that they develop inside of a froth-like substance resembling saliva produced in summer upon grass and various plants and trees. While none of these insects have yet become pests, there can be no doubt that collectively they do considerable harm to plants, as sometimes they are very abundant and subsist entirely upon their sap.

In this connection peculiar interest attaches to the contents of 20 stomachs of the pygmy nuthatch from the pine woods of Pacific Grove, near Monterey, June 24 to July 13. Eighteen of these stomachs contained remains of Cercopidæ, and six were filled with them. The average for the 18 stomachs is a little more than 76 per cent of all the food. They were not identified specifically, but undoubtedly are one of the several species known to feed upon the pine. Beetles of various families form about 12 percent of the food. There were many weevils, or snout-beetles, in the stomachs, and some coccinellids, which were the only useful insects found. They amount to 9.6 percent, which is the largest record for any bird yet examined, except the vireos; but as this percentage is based upon the examination of so few stomachs, it can not be considered as wholly reliable. Caterpillars amount to 8 percent, and with a few spiders (1 percent) account for the rest of the animal food.

Vegetable food.—The vegetable portion is made up almost entirely of seeds, of which a majority are those of conifers, as was to be expected from the habits of the bird.

Two other species of nuthatches, the slender-billed (*Sitta c. aculeata*) and the red-breasted (*Sitta canadensis*) occur in California. A few stomachs of each have been examined and the contents found to agree substantially with the foregoing.

SUMMARY.

In conclusion, it may be said that, like other genera of the Paridæ, nuthatches are eminently useful birds. They do not prey upon cultivated crops, eat but few useful insects, and probably are among our most efficient conservators of the forest and of the orchard.

PLAIN TIT.

(*Bœolophus inornatus.*)

(Plate V.)

The plain tit, like the rest of its family, is quiet and unobtrusive, attracting little notice by its voice and movements, and probably is the most modestly dressed of them all. While it seems to prefer to hunt on oaks, it does not neglect fruit trees, and often may be seen flitting about the orchard.

The general character of its food is the same as that of other small arboreal species. The relative proportions consumed, however, differ somewhat from those taken by other members of the family. The plain tit eats a greater proportion of vegetable food than any other titmouse so far as known, and, what is more remarkable, a large part of this consists of the pulp of fruit.

PLAIN TITMOUSE (BAEOLOPHUS INORNATUS).

The following brief account of the food of this bird can be considered only preliminary, as but 76 stomachs were available for examination. These, however, are distributed through the year, so that every month is represented by at least three. While these results may be modified by future investigation, they probably afford a fair general idea of the yearly food of the species.

Animal food.—Unlike most of the titmice, the plain tit eats less animal than vegetable food, the proportion being 43 percent of animal to 57 of vegetable. Examination of a greater number of stomachs may modify these figures but probably will not reverse them. The animal food is quite evenly divided among a number of elements, but, as with the bush tit, bugs (Hemiptera) appear to be the favorite, mostly eaten during the summer months. These amount to 12 percent of the food. This is a little more than one-fourth of the amount of Hemiptera eaten by the bush tit. The black olive scale is a prominent element of this part of the diet, and forms nearly 5 of the 12 percent. In the month of August nine stomachs were taken, and 34 percent of their contents consisted of these scales, while one stomach was filled with them. The plain tit probably eats this insect more or less throughout the year, but the limited number of stomachs under consideration does not warrant a positive statement. The other hemipterous food consists of representatives of several families, such as leaf-hoppers (Jassidæ), jumping plant-lice (Psyllidæ), tree-hoppers (Membracidæ), and other remains not identified.

Lepidoptera, represented mostly by caterpillars, are the next most important ingredient of the food. They amount to nearly 11 percent, and are mostly eaten during the warm months, though one stomach taken in March was filled with caterpillars and one moth.

Beetles (Coleoptera) are next in importance in the food, of which they form nearly 7 percent. All are harmful species, but the members of one family are especially interesting. The genus Balaninus is composed of weevils in which the snout attains its greatest length, and sometimes is as long as the rest of the body. The insects, by means of this long snout, bore into nuts and acorns, wherein they deposit eggs, which hatch grubs that eat the nut. The tit finds these beetles while foraging upon the oaks. One stomach contained the remains of 13 of them, another 11, a third 8, and a fourth 7, while others contained fewer. The plain tit feeds upon mast to some extent, and it is interesting to note that some of the stomachs which held remains of Balaninus contained acorn meat also, showing that the birds found the one while foraging for the other.

Hymenoptera in the shape of ants amount to nearly 4 percent, while wasps make up the total of this order to about 6 percent.

Other insects aggregate a little more than 5 percent. Tipulid flies (daddy-long-legs) were found in several stomachs, as were grasshoppers also. One stomach contained the remains of 13 of the latter, a remarkable number for so small a bird, but the bulk was not great, and they were probably the débris of several meals. Spiders are a very constant article of food, but do not appear in great numbers, as the average for the year is somewhat less than 1 percent.

Vegetable food.—In the vegetable food of the plain tit, fruit amounts to nearly 32 percent. Fruit is a rather surprising item of the food of this bird, as no one, so far as the writer can learn, has ever accused it of destroying fruit. The quantity is three times as much as is eaten by the linnet, and is another illustration of the fact that in estimating the status of a species the number of individuals as well as the amount eaten by each individual must be considered. The fruit consumed appears to be of the larger cultivated varieties, as no seeds of wild berries were found.

Cherries were identified in a number of stomachs, and pulp of the larger fruits was abundant. As considerable of this was contained in stomachs taken in the late fall and winter months, it is evident that it was refuse left on the tree and of no value. Not only does the plain tit eat fruit, but to some extent it indulges also in grain. Oats were found in a number of stomachs and constituted nearly 30 percent of the contents of two stomachs taken in January. Grain is probably not eaten to any considerable extent, however, as the amount for the year is but little over 1.5 percent, and oats was the only variety identified. Leaf galls, seeds of poison oak, weed seeds, unidentifiable matter and rubbish make up the remainder, 24 percent, of the vegetable food. None of these are of much economic importance, except that the distribution of poison-oak seed is a nuisance.

SUMMARY.

From this somewhat imperfect review of the food of the plain tit it is evident that in its present numbers it is useful. The insects it eats are practically all harmful and the scales exceedingly so. Moreover, its habit of foraging in trees enables it to capture some of the worst enemies of fruit and renders its work in this direction invaluable. On the other hand, it eats quite a large percentage of fruit, most of which appears to be of cultivated varieties, and should the bird ever become as abundant as the linnet now is it would undoubtedly be a pest. This contingency, however, is extremely unlikely.

CHESTNUT-SIDED CHICKADEE.

(*Parus rufescens* subspp.)

While this bird at present inhabits mountain regions rather than orchards, still it may not be out of place to give a short digest of our

knowledge of its food. Fifty-seven stomachs were available for examination, and these were taken in every month of the year, except March, April, and May. The food consisted of nearly 65 percent of animal matter and 35 of vegetable.

Animal food.—Caterpillars constitute 18 percent of the animal portion. They were found in nearly every month in which stomachs were taken, there being a fairly good percentage even in January and December. The greatest amount, 53 percent, was eaten in August. Hemiptera, consisting of leaf-hoppers, tree-hoppers, and olive and other scales, constitute the most important item of food, and amount to about 25 percent. These were found in all except two winter months. Wasps were eaten to the extent of 13 percent of the food, but no ants were found. Beetles amount to less than 2 percent of the food, but nearly all are noxious; weevils appeared in one stomach. Flies and grasshoppers are conspicuous by their absence, and not even a trace of one was discovered. Spiders are a very constant element of the food of nearly all the titmice. In that of the chestnut-side they amount to nearly 7 percent for the year, though in August they constitute nearly 16 percent.

Vegetable food.—The vegetable portion of the food consists of fruit pulp 8 percent, seeds nearly 20 percent, and miscellaneous matter 7 percent. Fruit pulp was found only in a few stomachs taken in the fall and winter and was probably waste fruit. The seeds eaten were mostly those of coniferous trees, as was to be expected of a bird which spends so much of its life in evergreen forests. The miscellaneous items of the vegetable food are leaf galls, bits of moss, and rubbish.

SUMMARY.

The above sketch of the chestnut-sided chickadee, while very imperfect, suffices to show the general character of its food. A few stomachs also of the mountain chickadee (*Parus gambeli*) have been examined and the contents found to agree in a general way with the food of others of the group.

WREN TIT.

(*Chamæa fasciata* subspp.)

This modest, secretive bird, like the eastern chat, is more often heard than seen. At present it does not often live in orchards and gardens, and when it visits these it sticks closely to hedges and the denser parts of the shrubbery. In general it keeps to its original abiding places in the dense chaparral of canyons and hillsides. So long as it is confined chiefly to these situations its food habits will never be of

more than secondary importance, but as cultivation spreads the bird will be forced more and more to reside in cultivated districts.

The number of stomachs available for examination is 165, and as they represent every month except July they afford a fair idea of the salient features of the bird's yearly food. Of this 52 percent is animal matter, insects and spiders, and 48 percent of various vegetable substances.

Animal food.—The most important item of the animal food consists of ants and wasps (Hymenoptera), which amount to 23 percent of the whole. This is in strong contrast to the bush tit, whose diet contains scarcely any of these insects. About half of the Hymenoptera are ants. This is exactly what might be expected of a bird of such terrestrial habits and one so given to lurking under bushes and about decayed logs and rubbish. The other insects of this order are small wasps. Beetles, collectively, the next most important item of food, amount to about 10 percent. The only useful species identified were a few ladybirds (Coccinellidæ), and a separate account of these was kept in order to estimate the harm done by their destruction. The result shows that the diet of the wren tit contains less than 1 percent of these useful beetles. The remaining beetles belong to various families, all of them harmful to vegetation. Caterpillars constitute a little less than 8 percent of the food, and are a very constant element of the diet. They appear to be eaten at all seasons, but in the early summer they amount to about one-fourth of the food. Quite a number of cocoons of tineid moths also were present in the food.

Bugs (Hemiptera) are eaten to the extent of about 7 percent of the animal diet. In this respect the wren tit differs from the bush tit, over 44 percent of whose food is made up of these noxious insects. In one particular, however, the two birds are alike; scales (Coccidæ) are prominent in the food of both. The black olive scale (*Saissetia oleæ*) and the greedy scale (*Aspidiotus rapax*) were identified in the stomachs of both birds, and many not specifically identified were found. The scales were probably obtained from orchards, as it is not likely that these insects have spread to wild plants and forest trees. As scales are to be had at all seasons they are a constant element of the food of tits. The remaining animal food, less than 5 percent, is composed of various insects and some spiders. One stomach contained the legs of a grasshopper and another the remains of a wood-cricket. These are the only orthopterous remains in any stomach. Flies (Diptera) were eaten very sparingly. Spiders appeared in a great many stomachs but not in large numbers. They amount to a little less than 2 percent of the food. In one stomach were found 26 mites, commonly parasitic on beetles and other insects. Their hosts had probably been eaten by the tit.

Vegetable food.—The vegetable contingent of the food, 48 percent, is made up of various substances, but may be arranged in three categories—fruit, poison-oak seeds, and other vegetable matter. Fruit, identified by seeds, pulp, and skins, amounts to a little more than 20 percent of the whole food. Few direct complaints, however, have been lodged against the wren tit on the score of damaging fruit, and yet this record is nearly twice that of the linnet—the bird against which the heaviest charges are made by the orchardist. The reason for this difference is probably not far to seek. There are undoubtedly a hundred linnets in California to one wren tit. This again illustrates the point before made, that the mischief done by birds usually results from a superabundance of the individuals of a particular species, all uniting simultaneously to attack some particular product. Moreover, the fruit consumed by the wren tit consists largely of wild varieties—such as elder berries (Sambucus), snow berries (Symphoricarpos), coffee berries (Rhamnus), twinberries (*Lonicera involucrata*), and others of a similar character. Seeds of blackberries or raspberries (Rubus) were found in a few stomachs, but these may have been either wild or cultivated.

As the seeds of poison oak (*Rhus diversiloba*) occurred in many stomachs a separate account of them was kept. From August to February, inclusive, they form a constant and important element of the diet. For these seven months they constitute more than one-fourth of the food, and the average for the year is over 16 percent. It seems natural enough that the wren tit should eat these seeds, as they are abundant and easily accessible. The fact is to be deplored, however, as they are not destroyed in the stomach, but either pass through or are regurgitated in condition to germinate. The seeds apparently are eaten for the sake of the rather thin layer of dry white pulp that surrounds them. No doubt this is very nutritious, as in winter poison-oak seeds are a common article of diet for many species of birds. The rest of the vegetable food, over 11 percent, is made up of a few weed seeds, leaf galls, and rubbish. None of it has special economic significance.

FOOD OF YOUNG.

Among the stomachs examined were those of a brood of 5 nestlings about two weeks old, and therefore nearly ready to leave the nest. The results are of interest as showing that the wren tit follows the usual rule and feeds its young entirely on animal food. The largest item is caterpillars, which amount to 63 percent of the contents. Spiders, with their cocoons and eggs, are next in importance, with 15.6 percent. Bugs, mostly leaf-hoppers, form 12.2 percent. Beetles of the May-beetle family, with a trace of eggshell,

make up the remainder, 9.2 percent. One can not fail to notice the soft nature of most of this food provided for the young. The beetles are the only exception, and these were the smallest item.

SUMMARY.

In summing up it is evident that so far as its natural food is concerned the wren tit does little or no harm, as coccinellid beetles, the only really useful insects it eats, are consumed very sparingly. Its vegetable diet presents two points for criticism. It eats a moderate amount of fruit, and were the bird as abundant as the linnet the harm it would do in orchards would perhaps more than counterbalance the good. The wren tit, however, naturally is a denizen of dense shrubbery, and as this is cleared away for farms and orchards the species is likely to diminish in numbers rather than increase, unless its habits radically change. The consumption of the seeds of poison oak is an unfortunate habit, since it aids in the dissemination of this poisonous plant, already too common and widespread. All things considered, the wren tit for the present is to be classed as beneficial.

CALIFORNIA BUSH TIT.

(*Psaltriparus minimus californicus.*)

(Frontispiece.)

The bush tit is one of the smallest species of the family, and although its name implies that it is partial to bushes, it more often is seen in large oaks and frequently on the tops of the highest trees. It shows the same indifference to the presence of man as the rest of the family, and frequently may be observed scrambling over orchard trees in search of its favorite food and paying no attention to the observer. That it does not prey upon fruit to an appreciable degree appears from the fact that less than 1 percent of its food for the year consists of fruit. Insects that live on trees, however, constitute four-fifths of its food, and most of these are harmful.

In the investigation of the food of this bird 353 stomachs were examined. They were collected in every month of the year, although April is represented by but a single one and March by only six. The greater number were taken during the growing months, when fruit and grain abound, and the fact that in these months the bird ate almost none of these products speaks volumes in its favor. The first analysis of the food of the year gives nearly 81 percent animal matter, composed entirely of insects and spiders, to 19 percent of vegetable. As the bush tit inhabits the same range during the year, monthly variations in the kind and proportions of food are only

such as seasonal changes necessitate, and as these do not largely affect insects, which constitute the great bulk of the bush tit's food, it follows that the variation in diet from one month to another is not great. The smallest quantity of animal food was in March, when it amounted to 53 percent, but the percentage was almost exactly the same for November. One stomach taken in April contained nothing but insects and spiders, and 11 collected in June contained no vegetable food. Probably examination of a greater number collected in these months would result differently. While the material available for the present investigation is not so extensive as could be desired, it is sufficient to indicate beyond reasonable doubt that the relative proportions of animal and vegetable food in the diet of the bush tit vary little from season to season.

Animal food.—The largest item in the insect portion of this bird's food consists of bugs (Hemiptera), which amount to over 44 percent of the whole. The gnatcatchers are the only birds yet investigated whose diet is made up so largely of this order of insects. Moreover, the particular families of Hemiptera so extensively eaten by the bush tit are the two that are most destructive to the interests of horticulture—namely, the plant-lice (Aphididæ), and bark-lice, or scales (Coccidæ). The last amounts to nearly 19 percent of the year's food, and are eaten in every month. The greater number are consumed in July, 46 percent; June follows second in rank, when they constitute 33 percent of the food of that month. The large black olive scale (*Saissetia oleæ*) was identified in 44 stomachs, but other species also were found. The question is often asked, Does any bird feed upon the San Jose scale? While the writer is not prepared to give a positive affirmative answer from direct evidence, there can be no reasonable doubt that this insect is often eaten by birds. It must be borne in mind, however, that the so-called San Jose scale is one of the smaller species, and its distinctive characters are so minute that after it has been taken into a bird's stomach, mixed with other food, and more or less digested, it is impossible to determine its identity. It is easy to ascertain that a pasty mass in a bird's stomach is composed of scales partly digested, but to identify the species is quite another matter. The olive scale and others of its genus, on the other hand, are so large and their shells are of such structure that they can often be identified, at least generically, even from fragments.

While the San Jose scale was not positively determined, another species of the same genus, the greedy scale (*Aspidiotus rapax*), was found in 4 stomachs, and scales not specifically identified were found in 113. Of a total of 353 stomachs, 158 held scales; several were entirely filled with them, and in quite a number upwards of 90 percent of their contents consisted of these insects. No other family of insects was identified in so many stomachs. As it is certain that the

food contained in a bird's stomach at a given time is only a fraction of the daily consumption, we may infer that not many days pass in the life of a bush tit when it does not eat a considerable number of scales.

Before leaving the subject it may be well to add a few words on the economic relations of scale-insects in order that the value of the work done by the bush tit may be fully appreciated. Mr. Marlatt says:

> The most destructive insect enemies of fruits in California are undoubtedly the scale insects, few if any other insects, aside from the grape Phylloxera, at all approaching them in this respect. Of these, the ones of greatest moment and in the control of which vast sums of money are expended are the black scale, the red scale, and the San Jose scale. For the olive and citrus plants the black scale is the most important, and for the deciduous plants the San Jose scale takes similar rank.[a]

When the immense number of bush tits and other birds in California that eat scale insects is considered, it becomes evident that the aggregate of these pests annually destroyed by them must be enormous. It may be urged that despite the attacks of birds, scales have caused, and still are causing, much damage to fruit trees, and that the work of birds alone is inadequate to save the trees from destruction. This is undoubtedly true, but it must be remembered that the birds are confronted with abnormal conditions. The great and rapid development of the fruit-growing industry on the Pacific coast and the simultaneous and widespread introduction of several new species of scales resulted in a sudden increase of these pests, while their enemies, the birds, enjoyed no such opportunities for increase. In time, no doubt, an equilibrium would have been reached, and birds would have played an important part in establishing this by exerting a constant and steady check upon the increase of scales. Unaided, however, their numbers are too few to cope with the insects which, under favorable conditions of climate and environment and unmolested by other natural insect enemies, multiply to countless myriads.

The remaining portion of the hemipterous food of the bush tit, over 31 per cent, is made up of plant-lice, tree-hoppers (Membracidæ), leaf-hoppers (Jassidæ), some jumping plant-lice (Psyllidæ), and a considerable number of false chinch bugs (*Nysius angustatus*), with a few lace-bugs (Tingitidæ). Of the plant-lice little need be said. As pests to vegetation their reputation is world-wide. No part of a plant is free from attack. They infest leaves, trunk, and roots, and some of their legions of species prey upon nearly every kind of land plant. They are a frequent element of the food of the tit, but as their

[a] Insect control in California, by C. L. Marlatt, U. S. Dept. of Agriculture, Yearbook, 1896, p. 220.

bodies are of the softest texture specific identification is not possible. Many of them, however, were determined to be of the species commonly called 'woolly aphides,' as their bodies are covered with a white cottony or woolly substance. Aphides were identified in 30 stomachs, but it is probable that they were contained in more, as a pasty mass that could only be called 'hemipterous remains' was of frequent occurrence. Leaf-hoppers were found in many stomachs, and appear to be favorite food. Tree-hoppers also are eaten to a considerable extent, and as their bodies are hard, like those of beetles, they are more easily recognized than plant-lice. The jumping plant-lice were found in a few stomachs, but were rather difficult to distinguish in the conglomeration of plant-lice and other soft-bodied insects. False chinch bugs were found in a number of stomachs from the southern part of the State. These, perhaps, were the best preserved of any of the insects, for in most cases they could be distinguished individually. Over 50 were taken from one stomach.

Next to the bug family, the favorite food of the bush tits seems to be beetles. They constitute somewhat over 10 percent of the year's food and attain their maximum in September, when they amount to a little more than 27 percent of the food. The fewest were taken in December—less than 1 percent—but in all the other months they were found to a moderate extent except in the one stomach taken in April, which contained none. Among them were species of the ladybug family (Coccinellidæ), which are useful insects, as they are mostly carnivorous and feed largely upon plant-lice. In order to ascertain just how much harm the tit does in devouring ladybugs, a separate account was kept, and it was found that the total amount eaten during the year was 2.4 percent of the whole food. Most of these insects were eaten in September and October, when the consumption amounted to 11 and 6 percent, respectively. These are the only decidedly useful insects eaten by the bush tit, and in view of their small number the subject may be dismissed without further comment. The other beetles taken were largely small leaf-beetles (Chrysomelidæ), all of which are harmful. With them were some small weevils (Rhynchophora), which feed upon seeds and other parts of plants, with a few scolytids that burrow under the bark of trees to their great injury.

Butterflies and moths (Lepidoptera), most of them in the larval form (caterpillars), are next to beetles in importance in the food of the bush tit. They are, however, far from being such favorite food as bugs. The total is a little more than 16 percent. They are fairly evenly distributed through the year, though in spring and early summer they are consumed to a somewhat larger extent than in fall and winter. The greatest consumption was in May, when they aggregated

nearly 69 percent. Lepidoptera in the adult form do not as a rule constitute an important part of the diet of birds, but, with the exception of the flycatchers, the titmice perhaps eat the most. The greater number consumed by these insects, however, are eaten as larvæ—caterpillars. A few, however, are eaten in the pupa state, and here the bush tit has a good record. In a number of stomachs were remains of the pupæ of the codling moth, one of the worst pests to the apple industry. This insect is protected from the attacks of birds by its peculiar mode of life. It passes the larval stage inside the apple. The adult moth flies mostly by night and hides during the day. When the larva is full grown it leaves the apple and seeks a place of concealment, such as a crevice in the bark of the tree, a crack in the trunk, or among rubbish on the ground, where it changes to a chrysalis. It is in this stage that the insect is most vulnerable to the attacks of birds, and as the whole family of titmice get most of their food by searching in just such places as those used for concealment by the larva, it is not surprising that they find and devour many of them.

The cocoons of certain tineid moths are a very constant, though not large, component of the food of the bush tit. The larvæ of many of the Tineina are leaf-miners, and therefore injurious when attacking economic plants.

Strangely enough, wasps and ants (Hymenoptera) are nearly absent from the food of this bird. The total amount for the year is less than 1½ percent. In view of the fact that ants are always crawling over the trunks and branches of trees, the very places where the tits feed, it seems strange that so few of them are eaten. Moreover, plant-lice always have ants in attendance upon them, and when tits eat so many plant-lice it is rather remarkable that they should not take some of the ants also, as do the smaller woodpeckers, whose food habits are in many respects so similar. In 353 stomachs only two ants were identified, one in the adult and one in the pupal stage, and these were in separate stomachs. In 17 other stomachs a few fragments of what probably were small wasps were found, which make up the total of the hymenopterous diet of the bush tit.

The remaining animal food of this bird, about 8 percent, is composed of various insects, such as a few flies, a few bits of grasshoppers, insects' eggs not further identified, with a considerable number of spiders. That the tits should not eat grasshoppers is not surprising, as these insects do not commonly infest trees where the birds feed, and as a rule they are rather large game for such small birds. The great bulk of the 8 percent, however, consists of spiders, which constitute a constant item of food in every month. Quite a number of pseudoscorpions also were found in the stomachs, but, owing to their minute size, the percentage is not very noticeable.

Vegetable food.—The vegetable food of the bush tit may be considered under two categories—fruit and miscellaneous matter. Fruit in some form was found in stomachs taken in the months from August to November, inclusive. The average amount eaten in those four months was a little less than 1 percent. It is represented in the stomachs by pulp and skins, which have not been further identified. The miscellaneous vegetable matter is composed of a few seeds, granules of poison oak (*Rhus diversiloba*), leaf galls, and rubbish. The seeds of poison oak are eaten by many birds, and so are distributed about the country, but, as a rule, they are too large to be swallowed by the tit, which contents itself with pecking off the wax surrounding the seed. This is identified in the stomachs by certain woody granules. A large portion of the vegetable food consists of small galls, apparently from leaves. They are eaten when first developed, when young and tender. As each of these probably contained an egg or grub, it is questionable if they should not be classed as animal food. The remainder of the vegetable matter is of such a nature that the only term which really describes it is 'rubbish.' It is probable that it is mostly taken accidentally along with other food, and perhaps should not be considered in the food category.

FOOD OF NESTLINGS.

Among the 353 stomachs of the bush tits whose food has been discussed was one brood of eight nestlings about ten days old. As these are the only nestlings collected, their food would merit attention, but examination shows it to be of unusual interest. The vegetable matter in these stomachs was only three-fourths of 1 percent and consisted of one seed and some rubbish. The animal matter comprised, approximately: Beetles 2, wasps 2, bugs 8, caterpillars and pupæ 80, and spiders 7 percent. The point of greatest interest, however, lies in the fact that every one of these stomachs contained pupæ of the codling moth, distributed as follows: Two stomachs contained 2 each, two contained 3 each, one contained 4, one 7, one 9, and one 11, making 41 in all, or an average of over 5 to each. The oak tree in which these birds were found was in a belt of timber along a creek, and just across the stream was a considerable area of neglected orchard. It is evident that the parent birds used this orchard as a foraging ground and did their best toward remedying the neglect of the owner. As with nestling birds feeding and digestion are almost continuous during the hours of daylight it follows that the above record would be several times repeated during a day's feeding. There were probably not less than a dozen nests of the bush tit (several were seen) along the border of this orchard, and if, as is probable, the occupants all did as good work as the ones

recorded it is evident that the birds must exert a powerful restrictive influence upon the increase of the codling moth, as well as other insects.

SUMMARY.

In a résumé of the food of the bush tit the most prominent points to be considered are the fact that four-fifths of its diet consists of insects and spiders, nearly all of which are harmful; that more than half of its animal food is limited to a single order of insects, Hemiptera; that it eats the particular families of this order which contain the worst of insect pests; that the vegetable contingent of the food is made up almost entirely of substances of no economic value. It is doubtful if more efficient checks upon the increase of many species of forest and orchard insects can be found than the titmice and other closely related species. Bush tits, therefore, are a valuable asset to the State of California and should be protected and encouraged in every possible way.

Following is a list of insects identified in the stomachs of bush tits:

COLEOPTERA.

Crepidodera helxines.
Diachus auratus.
Orthoperus sp.
Corticaria scissus.
Scymnus marginicollis.
Scymnus pallens.
Scymnus nanus.
Notoxus alamedæ.
Anthicus sp.
Apion vespertinum.
Deporaus glastinus.

HEMIPTERA.

Nysius angustatus.
Geocoris bullatus.
Saissetia oleæ.
Aspidiotus rapax.

LEPIDOPTERA.

Carpocapsa pomonella.

The following families of Hemiptera were identified:

Tingitidæ.
Capsidæ.
Membracidæ.
Jassidæ.
Psyllidæ.
Coccidæ.
Aphididæ.

KINGLETS.

Kinglets, like gnatcatchers and titmice, are small, active birds and spend most of their lives on trees. So nearly do the feeding habits of these diminutive arboreal species resemble each other that in winter it is not unusual to see companies of titmice, kinglets, creepers, and nuthatches all together, engaged in the same unending search for

food. When one notices how thoroughly each tree is inspected by dozens of pairs of keen, prying eyes, he is surprised that any insects or their eggs should survive to produce broods.

RUBY-CROWNED KINGLET.

(*Regulus calendula.*)

The ruby-crowned kinglet is known in California principally as a winter resident, though in some of the high mountains it remains through the summer and breeds. Its small size would prevent it from doing appreciable injury to fruit or grain were any to be had when it is in the fruit and grain raising regions.

As might be inferred from field observations, its diet consists almost entirely of insects and their eggs, and the number it destroys is beyond computation.

In investigating the food of the kinglet 294 stomachs were examined, all taken in California from September to April, inclusive. Only 1 stomach was collected in September, 5 in March, and 5 in April. The other included months are fairly well represented. The food consisted of 94 percent of animal matter and 6 percent of vegetable. It was made up of insects, spiders, and pseudoscorpions—minute creatures resembling microscopic lobsters—fruit, weed seeds, etc.

Animal food.—The animal food is quite evenly distributed through the season. The greatest amount, 100 percent, appeared in the first and last two months, and the least, 79 percent, in January. Hymenoptera, in the shape of wasps, and a few ants appear to be the favorite food, as they aggregate over 32 percent of the whole. The stomach taken in September contained none of them, but in every other month they are fairly well represented, and with but little variation until March, when there is a sudden increase, which continues in April. This is undoubtedly due to the increased numbers of these insects following the return of warm, dry weather, for the order is noted for its fondness for warmth and sunshine. Adverse criticism may be made upon this element of the kinglet's diet, as flying Hymenoptera are useful agents in the fertilization of flowers, and some species of plants are dependent upon them for the performance of this important function. The parasitic species of this order also were found to some extent in the food of the kinglet, and unquestionably many of these are decidedly useful.

In the food of the kinglet, bugs (Hemiptera) are next in importance. They constitute nearly 26 percent of the diet, and are found in greatest quantity in the first months of the bird's winter stay, in September and October, but gradually decrease till spring.

The following families of Hemiptera were recognized in the stomach contents: Assassin-bugs (Reduviidæ), lace-bugs (Tingitidæ), leaf-bugs (Capsidæ), leaf-hoppers (Jassidæ), tree-hoppers (Membracidæ), jumping plant-lice (Psyllidæ), plant-lice (Aphididæ), and scale-insects (Coccidæ). Stink-bugs (Pentatomidæ), which are the most universally eaten by birds of any Hemiptera, are entirely wanting. Evidently it was not lack of opportunity that prevented the kinglets from eating the last-named insects, for other birds collected at the same time and place had partaken of them freely. From the human point of view it is not strange that birds should reject them, for to us their odor is vile and their taste nauseous. It will be noticed that the Hemiptera selected by the kinglet are mostly species of small size, but happily they are the very ones that are the most harmful to the interests of man. The tree-hoppers, the leaf-hoppers, and the jumping plant-lice, when abundant, are pests, and often do great harm to trees and smaller plants, while the plant-lice and scale-insects are the worst scourges of the fruit grower—in fact, the prevalence of the latter has almost risen to the magnitude of a national peril. As has been before pointed out, it is these small and seemingly insignificant birds that most successfully attack and hold in check these insidious foes of horticulture.

Beetles of various families and species were eaten by the kinglet to the extent of 13 percent of the season's food. They belong to species that are more or less harmful, with the exception of a number of ladybirds (Coccinellidæ), which from their habit of feeding on plant-lice are eminently useful. The damage done by the destruction of these useful beetles, however, is small, since they aggregate less than 2 percent of the whole food. Singularly, nearly all were in stomachs obtained in February. In this month 8 percent of these beetles were eaten, while in no other month was so much as 2 percent taken. Another curious fact is that almost all of these belong to the genus Scymnus, which is made up of minute black creatures which one might think would pass unnoticed by birds. On the contrary, the small and insignificant individuals of this genus appear to be eaten much oftener than the larger and more showy species. While the eating of ladybugs by kinglets or other birds is to be deplored, it must be acknowledged that little harm is done so long as the numbers destroyed are as moderate as the above figures imply.

Of the harmful beetles eaten the weevils are perhaps the most interesting. One stomach contained 20 individuals, which seems a large meal in view of the size of the bird. Many of the weevils belong to the family of engravers (Scolytidæ), which live under the bark of trees and are forest pests. Another beetle found in many stomachs is *Notoxus alamedæ*, an insect that lives on trees, but which does no harm so far as known. One stomach contained the remains of

100 individuals of this species. Other beetles were found belonging to about a dozen families, all more or less injurious.

Lepidoptera, both larvæ (caterpillars) and adult forms (moths and butterflies) constitute only a small portion of the kinglet's diet. They were eaten sparingly in every month but one, but in all aggregate only 3 percent of the whole. While a few caterpillars were eaten, most of the lepidopterous food consisted of the minute cocoons of tineid moths, a family of immense size, wide distribution, and destructive habits. They are largely leaf-miners, and do much damage to the foliage of fruit and other trees. They are so small that even the little kinglet can eat a great many of them at a meal. In only 2 stomachs was anything found that resembled a grasshopper, and in both the quantity was small and the identification doubtful. Flies (Diptera) constitute nearly 17 percent of the diet, but are very unevenly distributed. The greatest amount in one month was in January, 35 percent, all of which was in 7 stomachs collected in the same place within three days. These 7 stomachs contained an average of 96 percent of dipterous remains. The birds evidently found a gathering of flies, probably dormant, and filled themselves almost exclusively with them. Another series of 4, taken at the same place in February, also had eaten flies to the extent of over 80 percent of the food. Spiders and pseudoscorpions amount to nearly 2 percent of the food, and are taken quite regularly through the season, though the greater number were eaten in October. These last are curious minute creatures, the various species of which live under stones, on the bark of trees, and in old books.

Vegetable food.—The vegetable food of the kinglets may be discussed under three heads—fruit, weed seeds, and miscellaneous vegetable matter. Fruit amounts to less than 1 percent of the food, principally elderberries (Sambucus). Weed seeds are present to the extent of a little more than one-tenth of 1 percent, and may therefore be dismissed without further comment. In the miscellaneous vegetable food two items include nearly the whole—seeds of poison oak and leaf galls—which together amount to somewhat more than 4 percent. The eating of the seeds of poison oak is not a commendable habit in any bird, for the seeds are not destroyed, but after the wax on the outside is digested are either passed through the intestine or disgorged, and so these harmful plants are disseminated. In many of the stomachs certain small round bodies were found that were diagnosed as 'leaf galls.' They appear to be galls in the early stage and are eaten while small and tender.

SUMMARY.

The foregoing discussion of the food of the ruby-crowned kinglet serves to confirm popular opinion with regard to this bird. As its

food consists so largely of insects and as these include so small a percentage of useful kinds, the kinglet must be classed as one of the most beneficial of birds. To the horticulturist it is especially valuable, as nearly all of its food is obtained from trees. With respect to the persistency with which it forages among trees, it differs conspicuously from such aboreal species as leave the trees in midsummer to feed upon grasshoppers.

WESTERN GOLDEN-CROWN KINGLET.

(*Regulus satrapa olivaceus.*)

Another kinglet, the western golden-crown, occurs sparingly in winter in some parts of California. Only 9 stomachs have been examined, but these in the nature of their contents are so similar to those of the ruby-crown that statements applicable to the latter are almost certain to apply as well to this species. No vegetable matter was found in any of the 9 stomachs, and the insects belong to the same orders and were taken in essentially the same proportions as by the other species.

Following is a list of beetles which were identified in the stomachs of the two kinglets:

Coccinella t. californica.
Adalia frigida.
Scymnus pallens.
Scymnus nebulosus.
Hesperobaenus abbreviatus.
Corticaria ferruginea.
Throscus sericeus.
Listrus interruptus.
Aphodius rugifrons.
Diachus auratus.
Crepidodera helxines.
Epitrix parvula.
Notoxus alamedæ.
Anthicus nitidulus.
Apion vespertinum.
Pityophthorus pubipennis.

Beetles were identified as belonging to the following families:

Staphylinidæ.
Coccinellidæ.
Monotomidæ.
Lathridiidæ.
Elateridæ.
Throscidæ.
Lampyridæ.
Malachiidæ.
Scarabæidæ.
Chrysomelidæ.
Tenebrionidæ.
Anthicidæ.
Curculionidæ.
Scolytidæ.
Other Rhynchophora.

GNATCATCHERS.

(*Polioptila* spp.)

Gnatcatchers are small, active birds of modest colors and unobtrusive notes. While not conspicuous, they are none the less deserving of respect and consideration. No complaints have been made that these busy creatures ever injure fruit or other crops. Their food

is composed almost exclusively of insects, which they hunt with untiring energy from morning till night. Like the titmice and kinglets, gnatcatchers are fitted by nature to perform a service which larger species are unable to accomplish. There are hosts of minute insects, individually insignificant but collectively a pest, that are too small to be attacked by ordinary birds and are to be combated by man, if at all, only at great expense. It is to so deal with such pests that they may not unduly increase that these tiny birds would seem to be especially designed. Three species of gnatcatchers live within the limits of the State of California. Two of them, *Polioptila plumbea* and *P. californica*, are confined to the southern part, while the third, *P. caerulea obscura*, occurs locally throughout the State. The material for a thorough discussion of the food of these birds is unfortunately not at hand, but there is enough to show conclusively the nature of the work they are doing, and to enable us to assign them their proper rank among the friends and helpers of mankind.

The food of the gnatcatchers is remarkably constant in character throughout the year, varying but little from month to month. It is probable that these birds have a preference for a certain diet, and search till they find it.

Only 30 stomachs of *P. c. obscura* and the same number of *P. californica* have been examined, and their contents were so similar that they may be treated as from a single species.

Vegetable food.—Of the 60 stomachs three only contained any vegetable food whatever, and in only one did it amount to a respectable percentage. This one held 92 percent of seeds of some species of Rhus; another contained 8 percent of unknown seeds, and the third a few bits of rubbish, which amounted to only 2 percent of the whole contents. The total vegetable matter in the 60 stomachs aggregated less than 2 percent of the entire food.

Animal food.—The remainder of the food, over 98 percent, is made up of beetles, wasps, bugs, and caterpillars, with a few flies, grasshoppers, and spiders. Bugs (Hemiptera) constitute more than half of the whole food, 64 percent. These belong to the families of stinkbugs (Pentatomidæ), shield-bugs (Scutelleridæ), tree-hoppers (Membracidæ), leaf-hoppers (Jassidæ), and leaf-bugs (Capsidæ), with perhaps traces of several others. In one stomach were 20 percent of black olive scales (*Saissetia oleæ*). All of these are harmful to trees and other plants. Wasps and a few ants (Hymenoptera) are next in importance as an element of the gnatcatcher's food, and amount to over 16 percent of the whole. These birds, like the flycatchers, take much of their prey on the wing, and it is probable that wasps and small bees are captured in this way. Beetles of several families were eaten to the extent of over 7 percent of the food, but no decided

preference for any particular kind is indicated. The only decidedly useful insects in any of the stomachs were 2 ladybird beetles (*Coccinella t. californica*), which had been eaten by *P. californica*. As this beetle is very abundant in California it is not surprising that birds should eat a few of them. Caterpillars amount to about 5 percent of the diet of the gnatcatchers. Apparently they are not a favorite food. Other insects, such as a few flies and grasshoppers, with some spiders, aggregate 6 percent, and probably are makeshifts, eaten when nothing more palatable is at hand.

SUMMARY.

While the foregoing discussion of the food of the gnatcatchers is based upon a small amount of material, the agreement of the evidence renders it probable that a much larger quantity would not greatly change the results. This evidence confirms what has long been suspected, that the gnatcatchers are doing a useful work and should be carefully protected.

RUSSET-BACK THRUSH.

(*Hylocichla ustulata.*)

The russet-back thrush abounds in the region about San Francisco Bay and other parts of the humid coast belt. It remains in this part of the State from April to November, inclusive, and then moves farther south for the winter. Its favorite haunts are the bushes and trees bordering streams, and in these it nests and rears its young.

While the thrush is very fond of fruit its partiality for banks of streams keeps it from frequenting orchards when they are far from water. It is most troublesome during the cherry season, at the time when the young are in the nest. It might be inferred from this that the nestlings are fed on fruit, but such is not the case to any noticeable extent. The parent birds eat the fruit themselves, while the young, as is usual with nestlings, are fed mostly upon insects. The old birds eat some fruit throughout the season, but do not seem to attract much attention by their depredations on prunes and the later fruits. As the thrush, unlike the linnet, is one of the so-called 'soft-billed' birds, its attacks on fruit are limited to the thin-skinned varieties. Probably it can peck holes in ripe cherries; still it is as often seen on the ground pecking at fallen fruit as attacking the fruit on the trees. It thus probably confines its depredations upon the later fruits to such as have already been broken into by linnets or other stout-billed birds.

Be this as it may, the thrush is an efficient destroyer of insects, and during the eight months of its sojourn in the fruit region a little more than half of its food consists of harmful insects. In the

investigation of this bird's diet 157 stomachs were examined. The birds came from various points about San Francisco Bay, and on the coast from Monterey to Santa Cruz, except one migrant which was taken in the southern part of the State. Only 6 stomachs were collected in April, 5 in October, and 7 in November. In the remaining four months 139 were taken, and as they are fairly evenly distributed the results for these months may be looked upon as reasonably reliable. Examination of the food shows 52 percent of animal matter to 48 percent of vegetable.

Animal food.—The greatest quantity of animal food was eaten in the first and last parts of the season—in fact, the six stomachs collected in April contained no trace of vegetable food. The animal matter decreases in each month up to September, in which month only 17 percent was eaten. From this month it increases, and ends with 62 percent in November. Too much reliance should not be placed upon the latter figures, as they were obtained from entirely too few stomachs, and are likely to be modified by the examination of more material. The animal portion of the food is mostly insects and spiders, with some earthworms and sowbugs (Oniscus).

Useful beetles (Carabidæ, Coccinellidæ, etc.) amount to less than 3 percent of the food of the year. Most of them are eaten at the beginning of the season before other insects are common. Other beetles, all more or less harmful, constitute 11 percent of the year's food, and are eaten chiefly the first of the season, decreasing toward fall but with a slight increase at the end. They are pretty evenly distributed among the more common families, and no decided preference is evident for any. It is probable that the thrush eats any beetles that come in its way, and does not make special effort to find a particular kind.

Caterpillars form somewhat more than 8 percent of the food, and while they are eaten in every month of the thrush's stay, they are taken much more freely previous to August. During and after that month they cease to be an important element of the diet. The average consumption of the first four months of the season is a trifle over 15 percent. Ants and wasps (Hymenoptera), bugs (Hemiptera), flies (Diptera), and grasshoppers (Orthoptera) are eaten by the thrush, although little preference is shown for any one of these except for Hymenoptera in the shape of ants. These are eaten with remarkable regularity throughout the season, and form about 16 percent of the food. This is the largest insect element in the food of the thrush, and the regularity with which ants are eaten would seem to indicate that they are highly esteemed and especially sought for.

While these insects do not often make themselves pests by directly attacking fruits and crops, they aid and abet the work of other insects in a way which renders them as bad as the worst of those directly

attacking crops. Their habit of caring for and protecting plant-lice is too well known to require extended comment. They take possession also of the empty burrows of wood-boring larvæ and extend these galleries still farther into sound timber. They often throw up mounds on lawns and in gardens, where it is almost impossible to exterminate them. In houses they frequently are an intolerable nuisance, infesting the pantry and spoiling food. The species that are not offensive in these various ways are mostly of a neutral character in their economic relations, and their destruction by birds does neither good nor harm.

Hymenoptera, other than ants (mostly wasps), bugs, flies, and grasshoppers, with some spiders, amount altogether to 12 percent of the year's food, and appear very regularly through the season. Grasshoppers, however, are near being conspicuous by their absence, as remains were found in only 4 of the 157 stomachs. This is rather remarkable for a bird whose habits are so terrestrial as those of the thrush. The majority of ground-feeding birds and many arboreal species feed largely upon grasshoppers. In fact, there is no order of insects for which insectivorous birds in general show such a decided preference. The spiders eaten by the thrush belong largely to the order Phalangida, commonly known as 'harvest men' or 'daddy-long-legs.'

Vegetable food.—The vegetable food of the thrush consists practically of fruit either wild or cultivated. A few weed seeds were found in several stomachs, but they amount to only a trace. It is probable that the greatest harm done by this bird is to the cherry crop, though undoubtedly it eats the later fruits to some extent. In May and June the fruit eaten reaches 41 and 38 percent, respectively, and this probably represents the greatest injury which the bird does, as most of the fruit was the pulp and skins of cherries. From June onward seeds of blackberries and raspberries (Rubus) were frequently found in stomachs, but as these berries are both wild and cultivated it is impossible to tell how much came from gardens. One stomach taken in early June contained seeds of the twin berry (*Lonicera involucrata*). Seeds of the elderberry (Sambucus) were abundant in stomachs taken in the late summer and fall, and indicate that this fruit constitutes a very considerable portion of the vegetable diet of the thrush at that season. Besides these were seeds of the pepper tree, of Solanum (a weed), and one stomach contained fruit of the coffee berry (*Rhamnus californica*). A few seeds of poison oak were found in two or three stomachs. The greatest amount of fruit was eaten in September, and reaches a total of over 80 percent, but as the number of stomachs is not as great as could be desired the result can scarcely be considered final. Moreover, a large part of this was wild fruit.

FOOD OF YOUNG.

Among the stomachs examined were those of 25 nestlings taken in June and July. Their approximate ages and dates of capture are given in the following table:

Brood No.	Number of young.	Age (approximate).	Date of taking.
		Days.	
1	Three	2	June 8
2	Four.....	8	June 8
3	Three	4	June 15
4	Three	14	June 19
5	Three	4	July 21
6	Two	3	July 25
7	Two	14	June 13
8	Five	7	July 16

Taking the collection as a whole their stomachs contained 92.6 percent animal matter to 7.4 percent of vegetable. Caterpillars aggregate nearly 27 percent and were found in every stomach but 7. No other element was so abundant. Beetles collectively are next in importance, with 22 percent. Of these the useful Carabidæ amount to 7.7 percent and are very irregularly distributed. All the remainder are more or less harmful species. Bugs (Hemiptera) aggregate 13.8 percent. Five families of these were identified, viz., stink-bugs, leaf-hoppers, tree-hoppers, shield-bugs, and cicadas. Ants and a few other Hymenoptera amount to 12 percent, and spiders to exactly the same. These last were mostly harvest-men or daddy-long-legs (Phalangidæ). A few miscellaneous insects amount to 6 percent, which makes up the whole of the animal food. Four stomachs of the russet-back contained remains of grasshoppers and three of these were nestlings. Carabid beetles were eaten by the young birds to the extent of 7.7 percent, which is more than three times the amount eaten by the adults. This is rather singular, for most of these insects are very hard-shelled and not at all the kind of food usually selected for young birds. Another interesting point is that all were contained in the stomachs of broods Nos. 2, 4, and 5. None of the other nestlings' stomachs held a trace of them.

The vegetable food amounts to 6.8 percent of fruit, with less than 1 percent of two or three other things. The fruit was nearly all either blackberries or raspberries, which were found in 11 stomachs, with twin berries in 1. One seed of filaree and some rubbish made up the rest of the vegetable food.

While the above affords a general idea of the food of these nestlings as a whole, there are some differences in the food of the different broods, which may be worthy of notice. The stomachs of broods Nos. 1, 2, and 6 contained no vegetable matter, as was the case with one each of broods 3 and 5. Broods 4, 7, and 8 had all eaten vegetable food,

but more than four-fifths of the whole was contained in the stomachs of broods 7 and 8. The average percentage for these two broods was over 22 percent, or about three times that of the whole. Again, Hemiptera, in the stomachs of broods Nos. 1 to 7, inclusive, amount to an average of less than 4 percent, but in brood No. 8 the average per stomach is over 53 percent of the food. Spiders were found in nearly every stomach of broods 1 to 4, while the other four broods contained very few. These facts indicate that birds exercise comparatively little choice as to the exact nature of their food, but take that which is nearest to hand. With a brood of hungry young incessantly clamoring for supplies little opportunity is afforded the busy parents to select precisely the kind of insects best adapted to the wants of the young. Nature teaches that insect food and not vegetable is needed and the gaping mouths are filled with the nearest obtainable supply.

In addition to the examination of stomachs of nestling thrushes field observations were made on the feeding of the young by the parent birds. Two nests of this species in the town of Hayward, Cal., were observed during several days in June and July, 1901. Each nest was watched for two one-hour periods on as many days as possible, and the number of times that the young were fed was carefully noted.

It may be said, to begin with, that the stomachs of young birds are kept constantly full during the hours of daylight.

Nest No. 1 was situated on a tree on the bank of a small creek on the edge of an orchard. When first observed, there were three young in the nest, apparently about five days old. This nest was watched for one hour from 9.40 a. m. on June 30, and the young were fed six times, but, as both parent birds came to the nest once with food in their beaks and went away without feeding the young, it is probable that they were not quite satisfied as to the intentions of the observer. At 4.25 p. m. of the same day another hour was spent in watching the nest, and the young were fed 11 times. On July 1, beginning at 8.30 a. m., 7 feedings occurred in one hour. This nest was not again watched until July 3 at 8.40 a. m., when the young were fed 8 times during the hour. In the afternoon of the same day, beginning at 3 o'clock, 12 feedings were observed in one hour. The last observation of this nest was made on July 5, beginning at 9 a. m. In an hour 13 visits with food were noted. In the case of this brood there were 57 feedings in six hours, or an average of 9½ feedings per hour. As there were three young, each one must have been fed a little more than three times per hour.

Nest No. 2 also contained three young, but they were only about 2 days old when first visited. The first observation was on June 30,

at 3.20 p. m., and the following hour the young were fed 8 times, and as the weather was cold the mother bird spent a number of minutes on the nest warming the nestlings. On July 1 another hour was spent in watching the nest, beginning at 9.30 a. m., and only 4 feedings were observed. It was, however, a cold, windy morning, and one or other of the parent birds remained on the nest all the time, leaving only when the mate brought food and took its turn brooding. The necessity for keeping the nestlings warm evidently prevented the parents from feeding them as often as customary. On the morning of July 3, although the weather was still rather cool, the birds seemed to be making up for the scanty feeding of the previous days, for they were observed to feed the young 15 times in an hour, beginning at 9.40 a. m., although they still took turns in warming the young for a few minutes at a time. In the afternoon of the same day, beginning at 4 o'clock, 8 feedings were noted in an hour. On July 5, beginning at 10 a. m., the parents were seen to feed the nestlings no fewer than 18 times, although one of them spent several minutes upon the nest three times during the hour. In the afternoon of that day 11 feedings were noted, in the hour beginning at 3.30, and 3 times one of the parents brooded the young, remaining once for six minutes. The next observation on this nest was made on July 6, during the hour from 7.50 a. m., and 12 feedings were noted. On July 7 the last observation was made, beginning at 3.20 p. m., and 11 feedings were noted. In this case there were 87 feedings in eight hours, or an average of nearly 11 per hour.

Considering both nests together, as each had the same number of young, we have 144 feedings in fourteen hours. Now at this time of year there are just about fourteen hours of available daylight, so that 144 feedings may be considered as an average day's work for a pair of parent birds, and as signifying the destruction of at least 144 insects, probably several times that number. Each of the three young must have been fed 48 times, which means that each stomach was filled to its full capacity several times during the day, another illustration of the fact that the digestion and assimilation of birds, especially of young ones, is constant and very rapid. This is further shown by the fact that when attempts have been made to raise young birds the experiments in most cases have failed because the nestlings were not fed often enough and actually starved to death. Young birds thrive best when fed a small quantity of food at short intervals rather than greater quantities at longer periods.

SUMMARY.

From the foregoing it appears that although this thrush eats considerable fruit it is not a pest to the fruit grower. Cherries seem to

be the only kind eaten to any considerable extent, and in the later summer wild fruit forms a large part of its vegetable diet. This thrush does not aid in the destruction of the seeds of noxious weeds.

In its insect diet the russet-back thrush is almost wholly beneficial, as it eats but few predaceous beetles or other useful insects. As young thrushes are fed almost exclusively upon insects, and as they eat almost continuously from morning till night, they must destroy an enormous number of these harmful creatures. From our present knowledge of its food and general habits, the russet-back thrush must be considered as one of our positively beneficial birds.

HERMIT THRUSH.

(*Hylocichla guttata.*)

The hermit thrush occurs in the valley and foothill parts of California only as a winter visitant. Thus it can destroy no fruit, except perhaps olives, and thus far no complaints have been made against the species in this respect. Although the bird has not yet attracted attention by depredations upon fruit, it may be well, nevertheless, to glance at its food habits as indicated by the contents of 68 stomachs. These were mostly taken in or about the Bay region, while a few came from the southern part of the State. Examination of the contents of these stomachs shows animal matter to the extent of 56 percent and vegetable 44 percent. The proportion of the two elements varies little in the different months.

Animal food.—Hymenoptera, mostly ants, constitute the largest item of the insect food. They amount to 24 percent, and appear to be eaten regularly in every month. This record is better than that of the russet-back. Caterpillars come next in importance, and form 10 percent of the food. They seem to be eaten rather more freely in February and March than in other months, though they are taken at all times of year. Predatory beetles (Carabidæ) are noticeable by their absence, as only a few remains of them appear. Beetles of other families, all harmful species, form 11 percent of the food. Weevils, or snout-beetles (Rhynchophora), constitute more than two-thirds of these, which would seem to indicate that they are a favorite food. When we consider that the carabids live on the ground, and are the most abundant and most easily obtained of any of the common beetles, and note how few of them the hermit thrush eats, while on the other hand it eats many snout-beetles, which, living to a great extent on trees, are generally much more difficult to find, we are forced to the conclusion that the latter are a preferred food, and that they are purposely sought for. Other insects, with some spiders and a few miscellaneous articles of diet (Oniscus), amount to about 12

percent. As in the case of the russet-back thrush, one stomach of the hermit contained the bones of a salamander.

Vegetable food.—The vegetable food is made up of two principal components—fruit and seeds. The former amounts to 29 percent of the whole, and is composed of wild species, or of old fruit left on trees and vines. A few stomachs contained seeds of raspberries, which, of course, must have been old, dried-up fruit. Seeds of the pepper tree and mistletoe were the most abundant and, with some unidentifiable pulp and skins, make up the complement of fruit. The hermit thrush eats more seeds than the russet-back, but does not stand high as a weed destroyer. Seeds of all kinds amount to 14 percent of the food, but only a few are usually reckoned as weed seeds. The most abundant seed was poison oak (*Rhus diversiloba*), which was found in a number of stomachs. While this plant is not usually classed among weeds, it is really a weed of the worst description, since it is out of place no matter where it is. It is unfortunate that birds in eating the seeds of this plant do not destroy them, but only aid in their dissemination.

SUMMARY.

On the whole, the food of the hermit thrush is remarkably free from useful products, destruction of which is a loss to mankind. The worst that can be said of the bird is that it eats and scatters the seed of poison oak, but it does not do this to a marked degree.

WESTERN ROBIN.

(*Merula migratoria propinqua.*)

In most of the valleys of California the robin is a winter resident only, and would be of little economic importance did it not possess a voracious appetite, the satisfaction of which occasionally leads to lamentable results. Of its summer food we know almost nothing, except what may be inferred from its list of edibles while in the valleys, and by comparison with the diet of its eastern relative. The two birds are so nearly alike that probably in the same environment they would eat practically the same things.

In investigating the food of the western robin 74 stomachs were examined. They were taken in every month from September to June, inclusive, except May. This number is entirely too small to be used as a basis for final conclusions, but it suffices to give a hint as to the differences, if any there be, between the food of the eastern and western races. Only one stomach was taken in each of the months of September, October, and June. The others are well distributed through the remaining months. Discarding returns from the three

months mentioned, 71 stomachs remain, from which a fairly reliable idea of the winter food of the robin in California may be obtained.

In the first examination we find 40 percent of animal food to 60 of vegetable. The food of eastern robins for the whole year contains 42 percent of animal matter to 58 percent of vegetable, and during the six months beginning on November 1 the amounts are: Animal 35 percent and vegetable 65 percent. If, however, our study is restricted to the three winter months, we find that the eastern robin eats 18 percent of animal food and 82 percent of vegetable, while for the same period the western one consumes 22 percent animal and 78 percent vegetable. These comparisons do not indicate essential differences in the food of the two birds. The western bird eats more insects during the winter months because on the west coast insects are more abundant and more easily obtained at that season than in the East. Confining attention, however, to the six months beginning with November, the eastern bird eats a greater percentage of insects. It is almost certain that if the material were at hand to illustrate the food of the western robin during the remainder of the year, the bird would be found to eat a much larger percentage of insects than in the six months covered by this investigation.

Animal food.—Beetles of various families are the largest item of animal food. The greater number were eaten in April, when they amount to over 54 percent of the whole food for the month. They were distributed among several families, but the most conspicuous were the snout-beetles, or weevils, which aggregated 25 percent. This is a favorable showing for the robin, for these beetles are among the most harmful insects with which the fruit growers and farmers have to contend. The average percentage of beetles for the whole six months is about 13 percent of the food. Caterpillars are next in order of abundance and amount to over 4 percent. The remainder of the animal food is made up of various insects, of which no order claims preeminence, and of a few angleworms.

Vegetable food.—The bulk of the vegetable food from November onward is cultivated fruit. After this month it gradually falls off, and very little was found in stomachs collected in March and April. With the exception of olives, the bird can obtain no fruit of value after the 1st of November, and as olives were not identified in any of the stomachs it is probable that most of the fruit consumed was worthless, having been left after the crop was gathered. The following fruits were identified: Grapes in 5 stomachs, figs in 3, prunes in 2, pear, apple, and blackberries in 1 each. Of wild fruit, pepper berries were found in 17 stomachs, mistletoe berries in 2, and fruit not positively identified in 11. Pepper berries evidently are the favorite, since not only were they found in the greater number of stomachs, but 1 stomach contained 24 and another 28 of these berries. Two

stomachs contained wheat and 3 had weed seeds, but dry seeds are evidently not favorite food with the robin.

Destruction of olives.—From the foregoing the robin would not appear to do much damage, or at least not more than is amply paid for by the insects it destroys. But, unfortunately, more is to be said about its food habits, which does not redound so much to its credit. In certain years when their customary food is scarce, robins appear in the valleys in immense numbers, and wherever there are olives they eat them so eagerly and persistently that the loss is often serious and occasionally disastrous. Sometimes, indeed, it is only by the most strenuous efforts, with considerable outlay of labor and money, that any part of the crop can be saved. Fortunately, such extensive damage is not done every year, although here and there the olive crop may suffer.

There is probably no more striking example of exceptional and intermittent damage to fruit by birds than an instance which occurred in the winter of 1900–1901. In that year the olive orchards in various parts of California were invaded by immense numbers of robins, which ate the fruit and in some instances destroyed the whole crop. In orchards where persistent effort was made to destroy and drive them away they still ruined from one-fourth to one-half of the yield. Olive orchards in Santa Clara Valley especially were afflicted. Mr. Paul Masson, who owns two orchards near Saratoga, as quoted by the San Jose Mercury of January 17, 1901, says:

> In my largest orchard of about 500 trees adjoining a larger orchard of about 50 acres on the El Quito farm, which is owned by E. E. Goodrich, are thousands of robins, which are destroying all the fruit on the trees. About two months ago I estimated that my trees would yield about 4 tons of olives, but Sunday, when I visited my orchard, I found the fruit would not be worth picking.
>
> I killed some of the robins, and upon examination found as many as five or six whole olives in the crop of each bird. Besides those which the bird had swallowed whole, many olives are pecked so that they are spoiled for market. Sunday there were not less than 50,000 robins on my place, and they are equally as plentiful on El Quito farm.

Mr. Edward E. Goodrich, the owner of El Quito farm and olive orchard, quoted by the same authority, says:

> The so-called robin is a destructive pest to an olive orchard. A crop can not be saved when the migration of the robin corresponds exactly with the maturity of the olive, as it does this year, except by immediate picking, which is practically impossible, or by shooting so constantly as to prevent steady consumption. * * * In 1898 my crop was 130 tons, and should have made about 4,000 gallons of oil. Owing to the lack of rain the result was about 2,750 gallons, of the value of $11,000. Now, that crop could have been wiped out in ten days by robins if they had been here as they were this season and no shooting had been done. So far as my foreman could estimate, before the birds descended upon the place, he placed the crop at a probable 3,000 gallons, which means when sold from $12,000 to $16,000, according to prices, and that would have been utterly destroyed but for the constant shooting the last ten days.

As it was, Mr. Goodrich placed his loss on the olive crop through the devastations of the robins at 25 percent of the whole, or about $5,000, while his foreman, in an interview with the writer, estimated the loss at 50 percent. He stated also that robins were so numerous that he killed 7 in a tree at a single shot.

The San Jose Mercury also states:

> A representative of the Mercury visited the El Quito olive orchard to see what the facts were in this matter. He found a force of men picking the fruit as rapidly as possible, and he also saw thousands upon thousands of robins doing the same thing. On his way out he occasionally saw a single bird on the fence or in a prune tree, but when he reached El Quito the sky was streaked with robins flitting about and having a gala time of it. Men were scattered about through the orchard with guns, and every few minutes the report of one of these would set the robins to flying, but in an instant they would settle down again and resume their feast.

Hon. Ellwood Cooper, of Santa Barbara, one of the largest olive growers on the Pacific coast, in a letter dated January 25, 1901, says:

> The robin is a terrible pest to olives. The birds do not always appear to come to the coast. My first experience was some fifteen years ago. The olives were late in ripening. I was as late as March making oil. The robins appeared to come in by the thousands. My last orchard that year was about one-half mile in length. The pickers were at one end. I had a man with a gun at the other, but they would attack the middle, and when the gunner would reach them they would fly to the end he left. This year they have been particularly bad. My boys reported that the birds, mostly robins, picked more olives than they could. The foreman of the pickers told me that he had knocked from a tree one-quarter of a sack and went to dinner; when he returned not an olive was on the ground. I know that on the ground in one orchard where the rain had caused to fall as many olives as would fill a bushel basket, in a week not one would be seen. The robins do not seem to be able to pick the olives so rapidly from the trees, but peck at those that are commencing to dry, knock them to the ground, then get them. The birds at this writing are in all my orchards by the thousands. They do not appear every year. It has been my theory that the native berries in the Sierra some years are not in sufficient quantities for food.

In the last sentence Mr. Cooper has probably suggested the true cause of the trouble. There is a crop of olives every year and the number of robins fluctuates little, but they rarely attack olives because usually their native food abounds. Where this fails the hungry birds shift about until they find a substitute.

SUMMARY.

With the exception of such sporadic cases as the above, the food habits of the robin are for the most part of a beneficial, or at least harmless, character. In the eastern part of the country very little damage by the robin is reported, though it is one of the most abundant species. This is probably largely owing to the plentifulness of wild fruits throughout the season. The trouble in California is that the robins from an extensive region concentrate into a comparatively

small area and, finding an abundant supply of palatable food, feed upon olives to the exclusion of all other food.

Were the hills and canyons of California as well supplied with wild berries as are the corresponding places in the Appalachian region, it is doubtful if such devastations of the olive crop would ever occur.

Since failure of the natural food supply of the robin is only occasional and can not be anticipated in advance, no direct safeguards against the bird's inroads are possible, though the planting of pepper and other berry-bearing trees about the orchards would materially aid in protecting the olive crop. The prompt and unsparing use of the shotgun when the emergency occurs, even though it seems to be the only practicable method to save the crop, is much to be deprecated, since the destruction of robins, which in the main are useful birds, is a loss to the community.

WESTERN BLUEBIRD.

(*Sialia mexicanus occidentalis.*)

The western bluebird has the same gentle, quiet demeanor that characterizes its relative of the Eastern States. It has not yet, perhaps, become quite so domestic as that species, but still is much inclined to frequent orchards and the vicinity of farm buildings. While the eastern bluebird usually nests either in a hole of an orchard tree or in the box specially provided for its use, the western species has not yet fully abandoned its habit of utilizing forest trees as nesting sites, and often may be found in lonely canyons or among the hills far from the abodes of man. The orchards of California as yet are hardly old enough to offer many hollow trees as nesting places of the kind so dear to the heart of our gentle friend. There is no reasonable doubt that in time the western species will become as domestic as the eastern one. A nest was found by the writer in a hollow tree in the home orchard of a ranch, only a few rods from the house. It contained six young, which would indicate that the bird is a prolific breeder, in this respect also resembling the eastern species.

The western bluebird is less migratory than the eastern and does not entirely desert the United States in winter; so its good work is continuous. As insects are active in California in every month the bird is able to support life even if there is no other food. Moreover, the insects eaten in winter count more in the reduction of these pests than do those taken after the spring broods are out. Insects that live through the winter are the stock by which the species is perpetuated, and the destruction of a few at this time is equivalent to the death in summer of hundreds or thousands.

The food of the bluebird consists of elements whose consumption is almost wholly a benefit to the farmer. Four-fifths of it is insects; only a small portion of these are useful, and these to a limited extent.

In the investigation of the food of the bluebird 187 stomachs were examined. This number is not so large as could be desired, and, moreover, was rather irregularly distributed over the year. Only one stomach was obtained in May, and only one in April, while the number for several other months are too few. Geographically they fairly well represent the fruit-growing regions of the State from as far south as San Bernardino northward to Santa Rosa. The food found in the stomachs consists of animal matter, 82 percent; vegetable, 18 percent.

Animal food.—Of the animal portion a little less than 12 percent consists of predaceous beetles (Carabidæ), which are usually reckoned as useful. There are, however, many exceptions to this rule, and since most of the species of this family are wonderfully abundant it is not probable that the bluebird does much harm by eating them. It is believed, moreover, that this record of Carabidæ is above the normal, for the one bird taken in April had eaten 90 percent of these beetles, thereby raising the average of the whole. In August, on the other hand, not one of the five birds examined had eaten a carabid. Had these months been omitted from the reckoning the average would have been reduced to about one-third of the present figure, which is probably much nearer the truth.

Other beetles amount to over 17 percent of the food, and were distributed among about a dozen families, all of them harmful, except three or four ladybirds (Coccinellidæ), which are useful.

Caterpillars evidently are a favorite food, and probably are eaten in every month, though evidence is wanting for April and May. They amount to over 17 percent of the year's food. Few of these insects are eaten in spring and early summer, many in fall and winter. As practically all caterpillars are harmful, this item of diet counts entirely in the bird's favor.

Grasshoppers and crickets, mostly the former, were eaten in every month except April, but a greater number of stomachs would probably give a different result. They amount to a little less than 24 percent of the year's food. They appear in the stomachs of western birds at a somewhat earlier date than in those of eastern species. In the Atlantic and Central States, August is preeminently the season of grasshoppers, and in that month they constitute the principal article of diet of many species of birds. The western bluebird eats grasshoppers in March to the extent of about 11 percent of its food. In June they amount to over 38 percent, and in July reach a maximum of nearly 49 percent, or nearly half of all that it eats. In September they amount to 40 percent, but decrease rapidly from that time.

Bees and wasps (Hymenoptera) are not largely eaten by the bluebird, and flies scarcely at all, as the aggregate for the year amounts to only four-tenths of 1 percent.

In the summer bugs (Hemiptera) are eaten to a moderate extent. The species belong mostly to the family of 'soldier bugs' (Pentatomidæ) or, as they are sometimes called, 'stink-bugs,' for they have a vile odor and when taken into the mouth with a berry are not agreeable to human taste. The total percentage of wasps, flies, bugs, and a few other insects is a little less than 10 percent of the whole food.

Spiders are eaten to some extent throughout the year, but never in great numbers. The greatest number are taken in February, about 6 percent. The total average for the year is 2 percent. One stomach contained the lingual ribbon of a snail.

Vegetable food.—The bluebird asks practically nothing of man in the way of vegetable food. It is evident that it is not a lover of seeds, as is the linnet, and with abundance of them at hand, eats few or none. In 2 stomachs several small unknown seeds were found, which may have been swallowed accidentally. Not a kernel of grain had been eaten. Fruit constitutes nearly the whole vegetable portion of the food, and was distributed as follows: Elderberries (Sambucus) in 19 stomachs; grapes in 12 stomachs, all in the month of October or later; blackberries or raspberries (Rubus) identified in 4 stomachs; pepper fruits in 2 stomachs; figs in 1 and mistletoe berries in 1. Besides these 9 stomachs contained pulp or skins that could be identified only as fruit. From this it appears that elderberries are the favorite fruit of the bluebird. Fortunately these are nearly always to be had in California. Most of the grapes eaten probably were waste fruit, as many of them were consumed in December and other winter months.

FOOD OF YOUNG.

Among the stomachs examined were those of several nestlings about a week old. They were of interest as showing how large a proportion of animal food is given to the young. In one brood of six the only vegetable food found was a single piece of plant stem, which was probably given accidentally with other food, and should properly be classed as rubbish. The real food consists of grasshoppers and crickets 90 percent, beetles 3 percent, and the remainder made up of bugs, caterpillars, and spiders. In another brood of four, grasshoppers and crickets constituted 97.5 percent of the food, and 1 stomach contained nothing else. The remains of 11 grasshoppers were found in one of these stomachs, and 10 grasshoppers, a cricket, and a beetle in another. The only vegetable matter found in these 4 stomachs was a single seed of Polygonum.

Besides the stomachs of the western bluebird discussed above, 14

stomachs of the Arctic bluebird (*Sialia arctica*) were obtained. They were taken in fall and winter, and while so small a number is not sufficient for positive conclusions, it may be said that the character of the food closely resembles that of the other species in the same months.

The two species eat about the same proportion of animal and vegetable food; the animal part consists of the same orders of insects, while the vegetable part is made up of the same varieties of fruit. In short, it may be said that if there are important differences in the food habits of the two birds the evidence at hand fails to establish the fact.

SUMMARY.

It seems scarcely necessary to comment on the foregoing statements with regard to the bluebird's diet in its economic relations. That the bird is an eminently useful species is so patent that it hardly needs to be pointed out. Whatever harm fruit growers have suffered from birds, none of it can be laid at the door of the bluebird.

List of insects identified in stomachs of bluebirds:

COLEOPTERA.

Coccinella t. californica.
Hippodamia convergens.
Polycaon stoutii.
Aphodius rugifrons.
Blapstinus dilatatus.
Blapstinus sulcatus.
Blapstinus pulverulentus.
Rhigopsis effracta.
Balaninus sp.
Sitones sp.

HEMIPTERA.

Saissetia oleæ.
Sinea diadema.

HYMENOPTERA.

Messor andrei (ant).

Insects also were identified as belonging to the following families:

COLEOPTERA.

Carabidæ.
Staphylinidæ.
Coccinellidæ.
Histeridæ.
Elateridæ.
Buprestidæ.
Lampyridæ.
Ptinidæ.
Scarabæidæ.
Cerambycidæ.
Chrysomelidæ.
Tenebrionidæ.
Rhynchophora (superfamily).

HEMIPTERA.

Reduviidæ.
Capsidæ.
Lygæidæ.
Pentatomidæ.
Corimelænidæ.
Scutelleridæ.
Jassidæ.
Coccidæ.

○

Date Due

Due	Returned	Due	Returned
NOV 2 0 1969	3 0 1969		
MAR 2 7 1972	MAR 7 1972		
DEC 1 4 1972	NOV 2 7 1972		
JUN 1 1 19[illegible]	JUN 0 7 1979		
SEP 1 7 1981	AUG 2 6 1981		
AUG 1 6 1984	JUL 2 5 1984		
JUL 1 1 1985	JUN 2 0 1985		
DEC 1 2 1985	DEC 0 3 1985		
[illegible] 1985			

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